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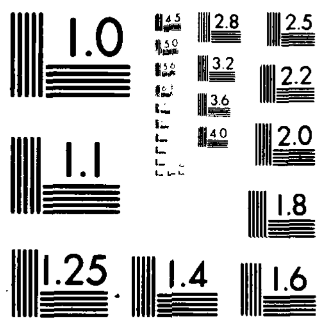

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MR 80-4

Sand Resources on the Inner Continental Shelf of the Cape May Region, New Jersey

by

Edward P. Meisburger and S. Jeffress Williams

AD A088636

MISCELLANEOUS REPORT NO. 80-4

JULY 1980

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U.S. ARMY, CORPS OF ENGINEERS
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Kingman Building
Fort Belvoir, Va. 22060

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REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER
MR 80-4

2. GOVT ACCESSION NO.
AD-A088 636

3. RECIPIENT'S CATALOG NUMBER
(9) (14) CERC-MR-80-4

4. TITLE (and Subtitle)
(6) SAND RESOURCES ON THE INNER CONTINENTAL SHELF OF THE CAPE MAY REGION, NEW JERSEY.

5. TYPE OF REPORT & PERIOD COVERED
Miscellaneous Report.

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)
(10) Edward P. Meisburger
S. Jeffress Williams

8. CONTRACT OR GRANT NUMBER(s)

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Department of the Army
Coastal Engineering Research Center (CEREN-GE)
Kingman Building, Fort Belvoir, Virginia 22060

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
D31665

11. CONTROLLING OFFICE NAME AND ADDRESS
Department of the Army
Coastal Engineering Research Center
Kingman Building, Fort Belvoir, Virginia 22060

12. REPORT DATE
(11) Jul[redacted]80 (12) 42

13. NUMBER OF PAGES
40

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)

15. SECURITY CLASS. (of this report)
UNCLASSIFIED

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Cape May, New Jersey	Sand resources	Seismic reflection
Geomorphology	Sediments	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

About 1,235 square kilometers of the Inner Continental Shelf adjacent to Cape May peninsula was investigated by a seismic reflection and coring survey to obtain geologic information on sea floor and subbottom sand and gravel deposits having suitable characteristics for use as fill in beach nourishment and restoration projects. Water depths in the study area ranged from about 1.5 to 21 meters. A total of 1,258 kilometers of seismic profiles and 104 vibratory cores, ranging in length from 1 to 3.7 meters, were examined.
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Linear and arcuate shoals are the dominant sea floor features in the region and most appear to be composed of clean, fine to very coarse-grained quartz sand which overlies a flat deposition surface. Several cores penetrating the surface show the underlying material to be a poorly sorted admixture of fine-grained and very coarse-grained sediments that are denser than the modern shelf sands and probably represent a pre-Holocene fluvial deposit.

Results of this assessment study show that 16 potential shoal sites and 2 promising sea floor areas are present. Individual shoals contain from 4.6 to more than 472 million cubic meters of sand; the total sand and gravel resource is conservatively estimated to be 1,086 million cubic meters.

PREFACE

This report is one of a series presenting results of the Inner Continental Shelf Sediment and Structure (ICONS) study. The primary objective of the ICONS study is locating and delineating offshore sand and gravel deposits suitable for beach nourishment and restoration. The work was carried out under the coastal processes program of the U.S. Army Coastal Engineering Research Center (CERC).

The report was prepared by Edward P. Meisburger and S. Jeffress Williams, CERC geologists, under the general supervision of Dr. C.H. Everts, Chief, Engineering Geology Branch, Engineering Development Division (EDD). As part of the research program of EDD, the ICONS study is under the general supervision of N. Parker, Chief of the Division. The fieldwork (obtaining cores and continuous seismic reflection profile records) was accomplished under contract by Alpine Geophysical Associates, Inc.

Microfilm copy of all seismic data is stored at the National Solar and Terrestrial Geophysical Data Center (NSTGDC), Rockville, Maryland 20852. Cores collected during the field survey program are in a repository at the University of Texas, Arlington, Texas 76010, under agreement with CERC. Requests for information relative to these items should be directed to NSTGDC or the University of Texas.

Comments on this publication are invited.

Approved for publication in accordance with Public Law 166, 79th Congress, approved 31 July 1945, as supplemented by Public Law 172, 88th Congress, approved 7 November 1963.

T.E. Bishop

TED E. BISHOP
Colonel, Corps of Engineers
Commander and Director

A

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CONVERSION FACTORS, U.S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

U.S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	by	To obtain
inches	25.4	millimeters
	2.54	centimeters
square inches	6.452	square centimeters
cubic inches	16.39	cubic centimeters
feet	30.48	centimeters
	0.3048	meters
square feet	0.0929	square meters
cubic feet	0.0283	cubic meters
yards	0.9144	meters
square yards	0.836	square meters
cubic yards	0.7646	cubic meters
miles	1.6093	kilometers
square miles	259.0	hectares
knots	1.852	kilometers per hour
acres	0.4047	hectares
foot-pounds	1.3558	newton meters
millibars	1.0197×10^{-3}	kilograms per square centimeter
ounces	28.35	grams
pounds	453.6	grams
	0.4536	kilograms
ton, long	1.0160	metric tons
ton, short	0.9072	metric tons
degrees (angle)	0.01745	radians
Fahrenheit degrees	5/9	Celsius degrees or Kelvins[1]

[1]To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use formula: $C = (5/9)(F - 32)$.

To obtain Kelvin (K) readings, use formula: $K = (5/9)(F - 32) + 273.15$.

SAND RESOURCES ON THE INNER CONTINENTAL SHELF OF THE CAPE MAY REGION, NEW JERSEY

by
Edward P. Meisburger and S. Jeffress Williams

I. INTRODUCTION

1. Background.

Initial restoration and periodic renourishment of beaches and dunes by placement of suitable sand along the shoreline is an effective means of counteracting coastal erosion and of enhancing recreational facilities (U.S. Army, Corps of Engineers, Coastal Engineering Research Center, 1977). In recent years, it has become increasingly difficult to obtain large volumes of suitable sand from lagoons and inland sources for beach nourishment because of economic and ecological factors. Accordingly, the Coastal Engineering Research Center (CERC) initiated an Inner Continental Shelf Sediment and Structure (ICONS) study program to locate and describe offshore sand resources suitable for beach nourishment. This report, a result of that effort, deals with the location and physical characteristics of offshore sand resources near Cape May, New Jersey.

2. Study Location and Data Coverage.

The ICONS study area comprises a 27.8- by 44.5-kilometer region of sea floor lying to the south and southeast of Cape May, New Jersey (Fig. 1). Data coverage in this area consists of 1,258 kilometers of seismic reflection surveys and 104 sediment cores ranging from 1 to 3.7 meters in length (Fig. 2). These data were supplemented by National Ocean Survey (NOS) hydrographic chart data.

This report is primarily the result of a reconnaissance effort; seismic line spacing and core density are not detailed enough for precise delineation of borrow sites. Consequently, more detailed study of promising locales identified in this report will be needed before specific borrow sites are identified for use in project design and construction.

3. Regional Setting and Sea Floor Morphology.

The study area, located at the southern end of the New Jersey coast within the New York Bight (longitude 75°02'30" to 74°30" W. and latitude 39° to 38°46' N.), is part of the Atlantic Coastal Plain province of eastern North America. The area is bounded to the north by Cape May peninsula, a headland section of the New Jersey coast, and to the west by the low-lying Delaware coast and the Delaware River shelf channel as defined by the 18.3-meter (60 feet) depth contour in Figure 1. The region surveyed covers about 1,166 square kilometers of the Inner Continental Shelf extending from the Cape May shoreface seaward to depths of about 37 meters (120 feet).

The coast of New Jersey can be divided basically into two physiographic parts. The northern part from Monmouth Beach to near Bay Head is a headland where older coastal deposits are in direct contact with the sea. The central part of the coast, including Sandy Hook spit protruding into New York harbor, is composed of low-lying sandy barrier islands and spits backed by shallow lagoons. The barriers are fairly continuous except for nine tidal inlets, and

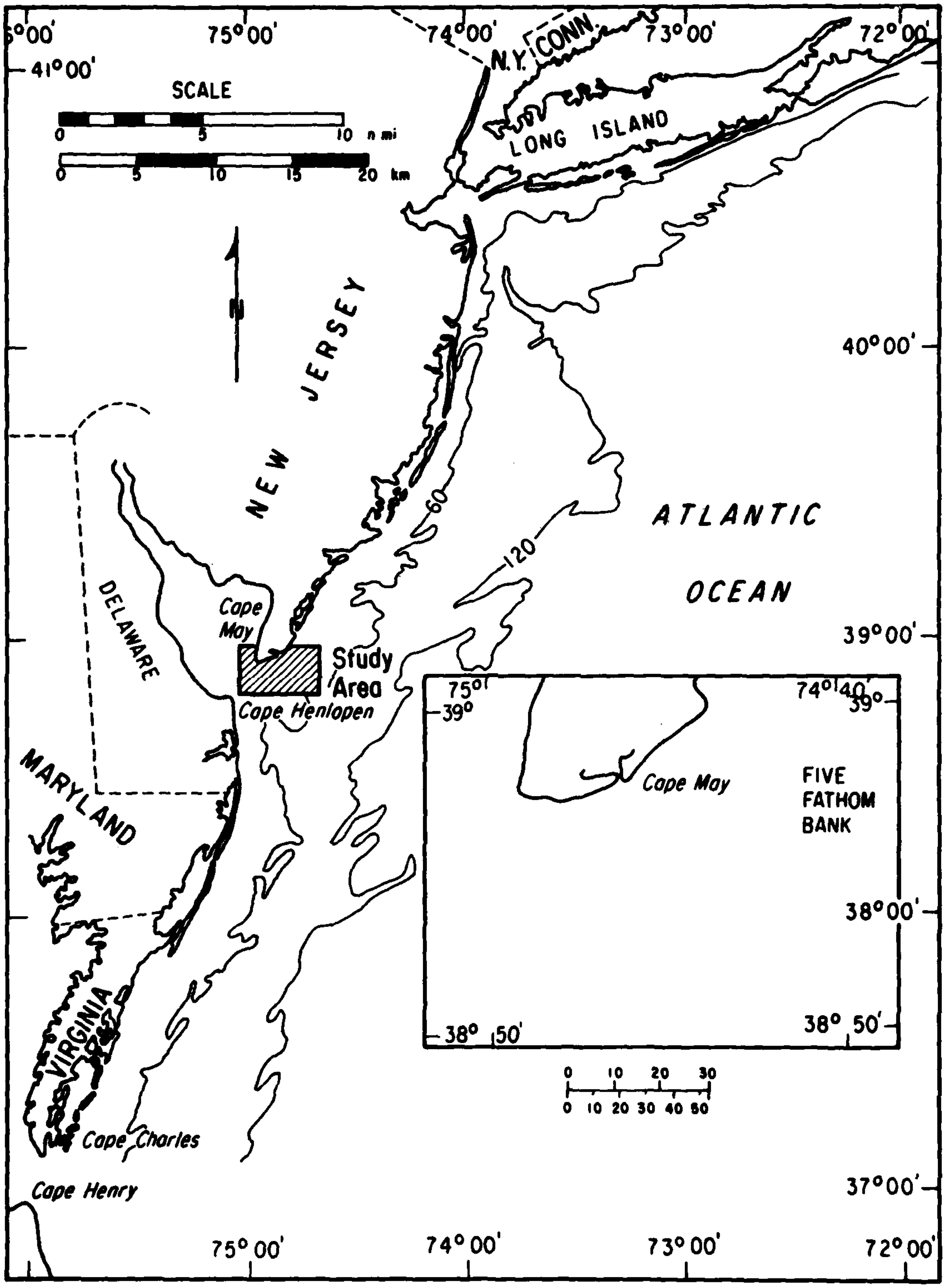

Figure 1. Cape May ICONS study area.

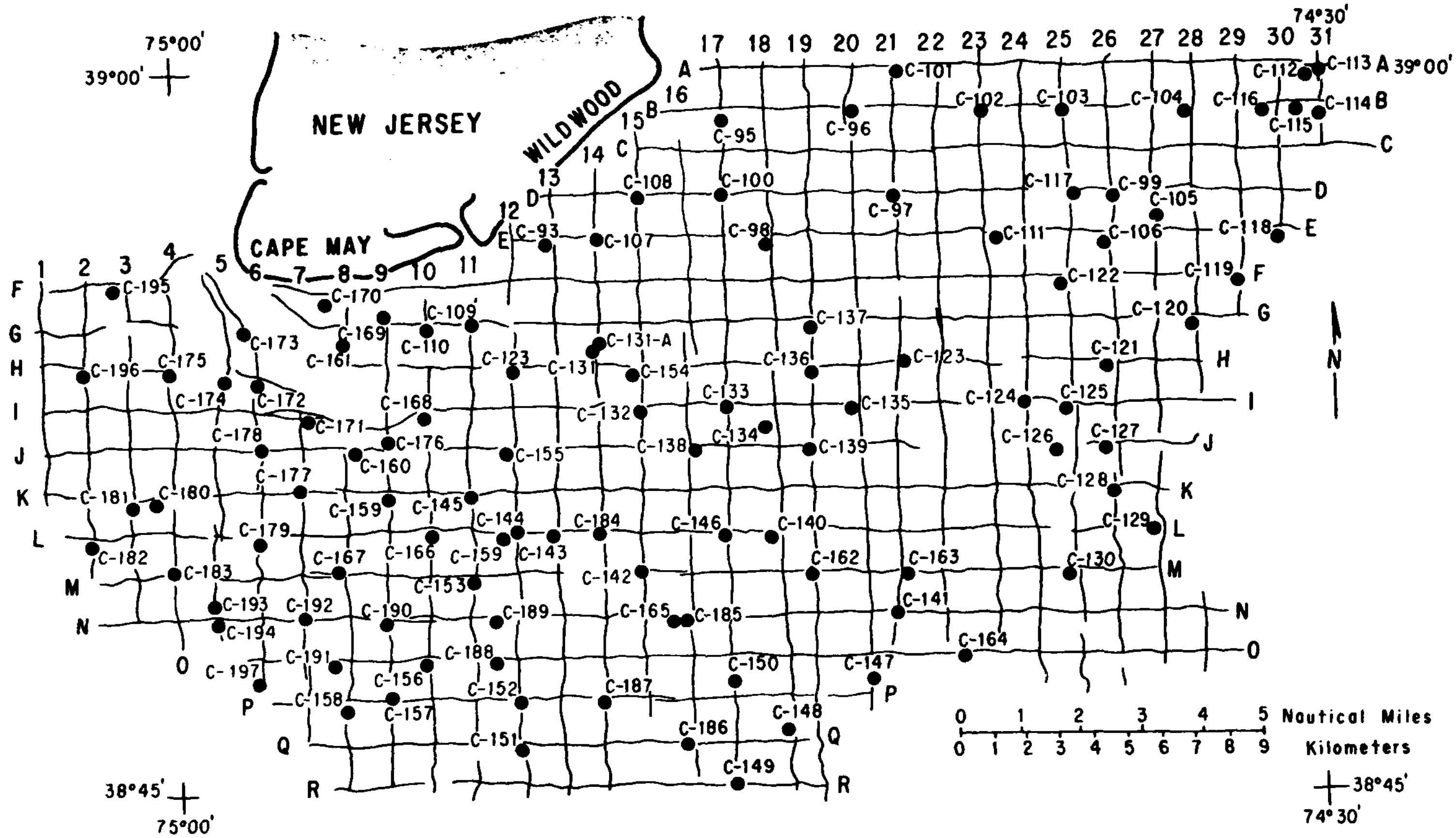

Figure 2. Location of seismic reflection profiles and vibratory cores used to access submarine sand resources.

extend in an irregular line south to Cape May city. The tip of Cape May peninsula from Cape May city west to Delaware Bay is also a headland where pre-Holocene sediments are directly exposed to coastal erosion.

The sea floor contours in Figure 3 show a very complex pattern, but the general ridge and swale topography trends northeast-southwest east of about longitude 74°45' W., whereas to the west the shoals are arcuate and parallel the Cape May coast. Five Fathom Bank (shown by the 2-meter (-36 feet) contour in Figure 3) is an exception to either fabric by its north-south orientation and probably owes its origin to processes that are different from those that form and modify most shoals in the area. The shoals on the Delaware shelf west of the Delaware Channel are quite different in orientation by trending to the northwest.

4. <u>Sediments.</u>

Sediments recovered from cores of the study area can be divided into two general age groups. The younger group consists of Holocene marine sediments which are distinguished by their small content of invertebrate remains; the presumably older group of sediments is mostly barren of animal remains. The most abundant Holocene deposit is a clean, pale-brown quartz sand, locally with admixtures of granules and pebbles. Sand size ranges from fine to very coarse (Wentworth Scale in Table 1). Sorting is predominantly poor especially in the coarser sand faces. Also included in the presumed Holocene deposits are silt, clay, and silty, sandy gravel which are probably relict transgressive back-barrier or reworked deposits from older substrate.

Below the Holocene sediments is a diverse group of pre-Holocene sediments consisting of sands, sandy gravel, silt, and clay. These deposits are complexly distributed with little vertical or lateral continuity. Although pre-Holocene sediments of similar character occur throughout the area, available data suggest that these deposits are not directly connected but rather that lithologic similarities are due to common source areas and recurrence of similar depositional conditions. The heterogeneous character and highly discontinuous distribution of these sediments suggest fluvial deposition. Nonmarine depositional conditions are also suggested by the absence of any marine organic remains, although this could be due to leaching.

Sediments recovered by cores taken during the ICONS survey are described in the visual core logs of Appendix A. Grain-size data for selected surveys are presented in Appendix B. Most of the sediments can be grouped in a number of characteristic types (summarized in Table 2); letters keyed to these types are used in the log descriptions (App. A) to identify sediments which correspond to the general character of a given type description. The similarities between sediments in a particular group do not necessarily indicate a stratigraphic relationship, although this may be true in some cases. Sediment types A, B, and the type C sediments containing shell are considered Holocene; the remaining types are probably of pre-Holocene age.

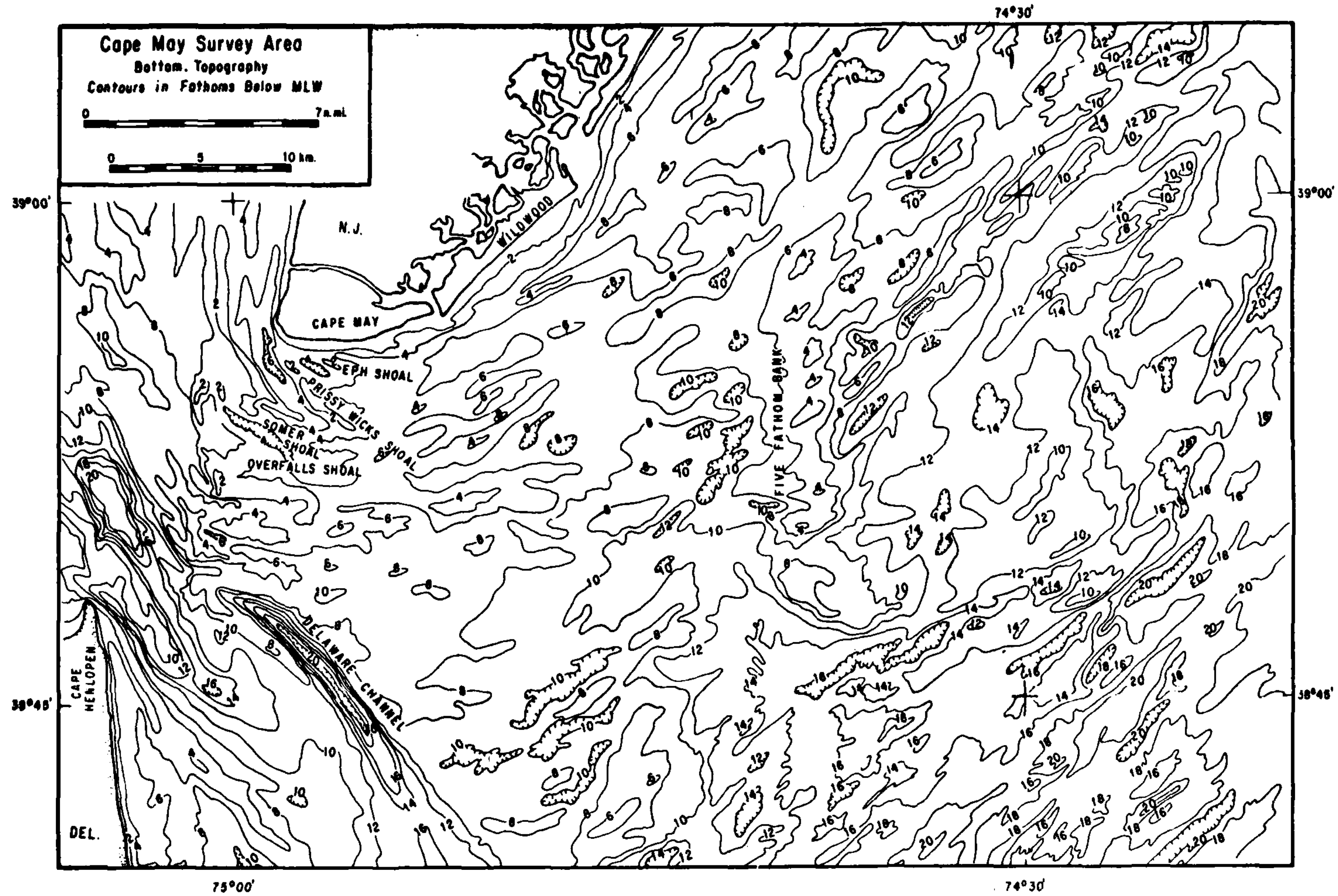

Figure 3. Bathymetric map of the Cape May Inner Continental Shelf.

Table 1. Grain-size scales--soil classification (modified from U.S. Army, Corps of Engineers, Coastal Engineering Research Center, 1977).

Unified Soils Classification	ASTM Mesh	mm Size	Phi Value	Wentworth Classification
COBBLE				BOULDER
		256.0	-8.0	
				COBBLE
		76.0	-6.25	
COARSE GRAVEL				
		64.0	-6.0	
				PEBBLE
		19.0	-4.25	
FINE GRAVEL				
	4	4.76	-2.25	
SAND coarse				
	5	4.0	-2.0	
				GRAVEL
	10	2.0	-1.0	
SAND medium				SAND very coarse
	18	1.0	0.0	
				SAND coarse
	25	0.5	1.0	
				SAND medium
	40	0.42	1.25	
SAND fine				
	60	0.25	2.0	
				SAND fine
	120	0.125	3.0	
				SAND very fine
	200	0.074	3.75	
SILT				
	230	0.062	4.0	
				SILT
		0.0039	8.0	
CLAY				CLAY
		0.0024	12.0	
				COLLOID

Table 2. Primary shelf sediment classes.

Type	Lithology	Description
A	Quartz sand	Typically very pale brown (10 yr 7/3)[1], fine to coarse grain size; 1 to 5 percent shell (predominantly *Spisula*), well to poorly sorted; silty in places but predominantly clean.
B	Silty sand and gravel	Typically variable grayish-brown color; shells comprise 1 to 10 percent; generally very poorly sorted, silty, and occurs in thin layers in most places; frequently consists of reworked substrate.
C	Silt and silty clay	Typically gray (5 yr 6/1) but occasionally brownish gray; mostly barren but contains shells in places; washed residues may contain sand, mica, and pieces of vegetation.
D	Clean to silty sand	Typically grayish brown (10 yr 6/1 to 10 yr 7/2); ocassionally yellowish or reddish-yellow very fine to fine sand; generally well sorted; micaceous locally.
E	Sand and gravel	Typically very light gray (5 yr 7/1) but often grayish to reddish brown; very poorly sorted sand, predominantly quartz; granules and pebbles consist mostly of quartz and rock fragments.
F	Quartz sand	Typically very light gray (5 yr 7/1) but often grayish to reddish brown; very similar to type E but with little or no gravel; poorly sorted, quartz predominant mineral.

[1]Munsell Soil Color Code (Munsell Soil Color Charts, 1944 ed., Munsell Color Co., Inc., Baltimore, Md.).

II. POTENTIAL BORROW AREAS

1. Sand Requirements and Beach Characteristics.

Studies by Krumbein and James (1974), James (1975), and Hobson (1977) have shown that the suitability of sand for beach nourishment is largely dependent on grain size and sorting. Sampling of beach and shoreface sands, native to the Cape May coast,by the U.S. Army Engineer District, Philadelphia (1979) indicates that fill sand should be in the fine to medium range or coarser (0.125 to 0.5 millimeter, 3 to 1 phi) for Cape May city, and at least medium to very coarse sand (0.25 to 2.0 millimeters, 2 to -1 phi) for the shore in Lower Township to the west (Wentworth Scale in Table 1). Identification and selection of the borrow areas described below are based on these criteria.

2. Borrow Areas.

The locations of 16 potential borrow areas where sand judged suitable for beach restoration and nourishment may be recovered are identified by letters in Figure 4. Table 3 provides a summary of the pertinent data for the deposits. The first part of the table contains information for the shoal deposits of Holocene marine sand. Volume calculations have been made for the Holocene marine sand deposits where seismic reflection and topographic control are sufficient for a reasonably reliable estimate. The second part of Table 3 contains data on sites identified by core number where the specified core recovered potentially usable sand, but from deposits which were not associated with any discernible

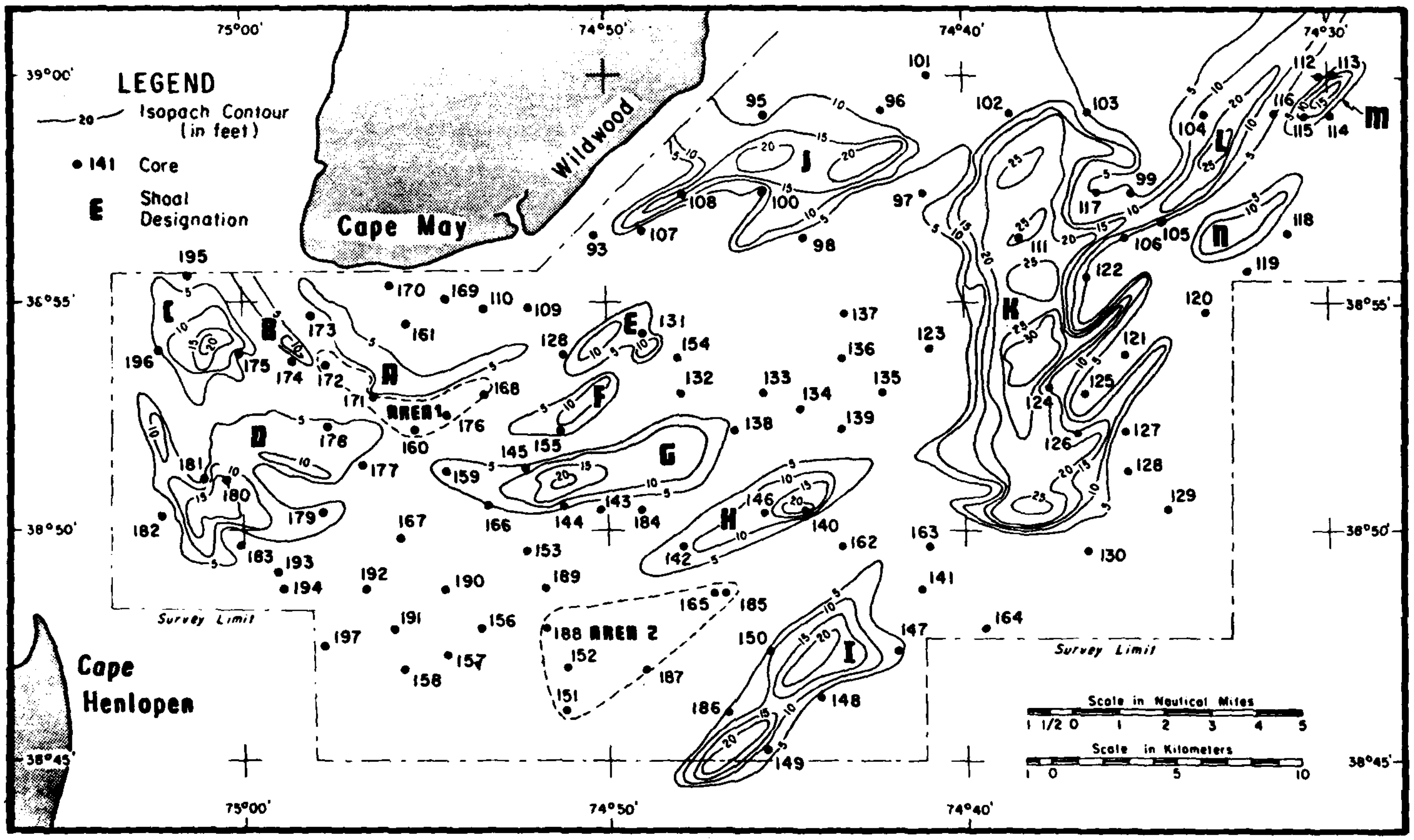

Figure 4. Isopach (thickness) map of the major shoals containing Holocene-age marine sand suitable for beach nourishment. Shoals A to N and areas 1 and 2 are discussed in the text.

Table 3. Summary of potential borrow areas.

Designation	Type deposit	Water depths (ft)	Area (yd^2)	Overburden thickness (ft)	Deposit thickness (ft)	Estimated volume (yd^3)	Cores in deposit	Sediment type	Sand size (Wentworth Scale)
Shoal A	Marine	6 to 30	10,914,000	0	5	18,182,000	None	A	No data
B	Marine	6 to 12	3,555,000	0	5 to 10	6,499,000	None	A	No data
C	Marine	12 to 38	14,617,000	0	5 to 20	41,079,000	175	A	Medium to coarse
D	Marine	10 to 42	38,962,000	0	5 to 15	89,265,000	178,179,180	A	Medium to coarse
E	Marine	23 to 33	6,765,000	0	5 to 10	14,644,000	131	A	Medium
F	Marine	22 to 34	5,990,000	0	5 to 10	13,163,000	155	A	Medium to coarse
G	Marine	18 to 42	29,417,000	0	5 to 20	84,328,000	144,145,159,166	A	Fine-coarse
H	Marine	44 to 53	20,099,000	0	5 to 20	53,230,000	140,142,146	A	Medium-coarse
I	Marine	40 to 60	33,778,000	0	5 to 20	120,860,000	147,149,150,186	A	Fine-medium
J	Marine	18 to 42	54,222,000	0	5 to 20	189,554,000	95,96,108	A	Fine-medium
K	Marine	20 to 60	125,580,000	0	5 to 30	617,437,000	99,102,103,106, 111,117,124,126	A	Medium-coarse
L	Marine	26 to 60	25,383,000	0	5 to 25	94,943,000	104,116	A	Fine-coarse
M	Marine	44 to 65	3,901,000	0	5 to 20	10,794,000	113,115	A	Medium
N	Marine	50 to 65	8,543,000	0	5 to 10	20,979,000	None	A	No data
Core 118	Marine	79	---[1]	0	>7	---	118	A	Fine to coarse
128	Marine	77	---	0	6	---	128	A	Fine to coarse
133	Marine	51	---	0	6	---	133	A	Medium
154	Marine	46	---	0	7	---	154	A	Fine to medium
167	Marine	40	---	0	6	---	167	A	Medium
101	Fluvial	55	---	2	3	---	101	A,F	Fine to very coarse
151	Fluvial	53	---	1	>7	---	151	A,E	Fine sand to granules
152	Fluvial	55	---	2	>6	---	152	A,F	Fine to coarse
160	Fluvial	34	---	2	6	---	160	A,E,F	Fine to coarse
165	Fluvial	65	---	2	>6	---	165	A,F	Medium to coarse
168	Fluvial	42	---	3	>5	---	168	A,F	Coarse sand and granules
169	Fluvial	36	---	4	>5	---	169	D,F	Fine to coarse
171	Fluvial	37	---	1	>6	---	171	A,E,F	Fine to coarse
172	Fluvial	33	---	1	>6	---	172	A,E,F	Fine to coarse
185	Fluvial	63	---	1	>7	---	185	A,F	Medium to coarse
188	Fluvial	48	---	5	>6	---	188	A,F	Fine to medium

[1]Unknown.

topographic or seismic reflection features. For this reason core data could not be projected beyond the immediate area of the core site and no area or volume calculations could be made. Several of these sites contain Holocene marine sand (type A) which does not seem to be associated with a prominent shoal. The remaining sites contain type E of F material which is thought to be pre-Holocene fluvial sediment. All of the pre-Holocene deposits are beneath some overburden, which mostly consists of suitable type A sand. Thus, the combined thickness of both units is considered usable. Many of the cores bottomed in usable material and their thickness are shown as greater than the specified amount of core recovery.

Eleven cores containing usable type E and F material are grouped into areas designated as areas 1 and 2 in Figure 4. It is possible that continuity of these deposits exists throughout the area. If this is true, a potentially usable volume of more than 14.5 million cubic meters of material could be recovered from area 1 and 20.6 million cubic meters from area 2. However, if these are fluvial deposits it seems unlikely that deposition was continuous over such a large area. Additional detailed coring in areas 1 and 2 is necessary to properly define the deposit before these areas can be considered high potential sites for sandfill.

Of the 16 separate borrow areas identified in Figure 4, shoals A,B,C,E,F, J and area 1 should definitely be considered as sources of fill for any projects along the Cape May coast. They are within about 9 kilometers of the coast, all have water depths less than about 12.8 meters (42 feet), and their combined sand resources are estimated to be more than 216 million cubic meters, more than enough to meet projected fill requirements for beach nourishment projects. Brief descriptions of these sites are given below.

a. Borrow Area A and Area 1. Area A (Fig. 4) is an elongate and arcuate shoal (named Prissy Wicks shoal on NOS chart 1219) that semiparallels the coast at the end of Cape May. Area 1 is a rather flat extension of the south flank of the shoal and is composed of fluvial sands that probably underlie the entire Prissy Wicks shoal complex. The seismic data in area A and the seismic and core data in area 1 show that sand about 1.5 meters thick is present; the combined estimated sand resources are more than 28.3 million cubic meters.

b. Borrow Area B. Area B consists of a narrow fingerlike shoal (named North Shoal on NOS chart 1219) adjacent to areas A and 1. Core 174 off the southern flank shows that the shoal is composed of medium to coarse sand underlain at the base by fine-grained sediment.

c. Borrow Area C. Area C is a concentric shoal (Fig. 4) immediately west of area B and about 5.4 kilometers from the western side of Cape May peninsula. The area comprises Round and Middle Shoals (on NOS chart 1219), and the seismic data and core 175 show that it contains up to 6.1 meters of a poorly sorted mixture of fine to very coarse pebbly sand.

d. Borrow Areas E and F. These areas are two closely spaced shoals within 7.2 kilometers of Cape May Inlet; they probably offer the highest potential as sources of nourishment sand. The CERC data show that medium to coarse sand is present to about 3-meter (10 feet) depths and the combined estimated sand volumes are more than 21.3 million cubic meters.

As a result of CERC recommendations, the U.S. Army Engineer District, Philadelphia, conducted additional detailed surveys of area E to evaluate it as a primary source for fill as part of their beach erosion control and storm protection study for Cape May and Lower Township (U.S. Army Engineer District, Philadelphia, 1979). In September 1978, 27 vibratory cores and 47 kilometers of fathometer profiles were collected in a fairly dense matrix with a core spacing of about 305 meters. Analyses of the cores confirmed that clean, medium-grained sands with a median diameter of 0.4 millimeter (1.27 phi) are present to depths of about 3.7 meters (12 feet). The penetration records from the cores also showed that the sands at the base of the shoal are very dense which suggests that marine Holocene type A sediments in the shoal are underlain by fluvial pre-Holocene silty sands.

e. Borrow Area J. Area J is a fingerlike shoal detached from the lower shoreface off Two Mile Beach to the east of Cape May Inlet. Core 108 and the accompanying seismic data show that suitable sand to a thickness of at least 6.1 meters is present and the estimated volume is about 145 million cubic meters, which makes area J the second largest (the largest is Five Fathom Bank in area K, with 472 million cubic meters) potential borrow area in the study area. Although the area offers much promise as a fill source, it is a minimum of 5.4 kilometers from the Cape May beaches and may be better suited to possible future projects along the Wildwood shore.

III. SUMMARY

A geologic study using seismic reflection profiles and sedimentary cores (a maximum of 3.7 meters long) was made of the Inner Continental Shelf region off Cape May, New Jersey, to locate and delineate sand and gravel suitable for beach restoration and maintenance.

Results of the study show that 18 sites identified on isopach maps contain an estimated 1,086 million cubic meters of sand. All but two sites constitute linear and arcuate shoals that are Holocene features composed of clean, marine quartz sand. The shoals are about 6.1 meters thick and appear to rest on a pre-Holocene fluvial surface composed of dense silty sand and gravel.

Six shoals (A,B,C,E,F, and J) and area 1 (Fig. 4) are closest to Cape May beaches and contain about 216 million cubic meters of sand, making them the best sites for future consideration.

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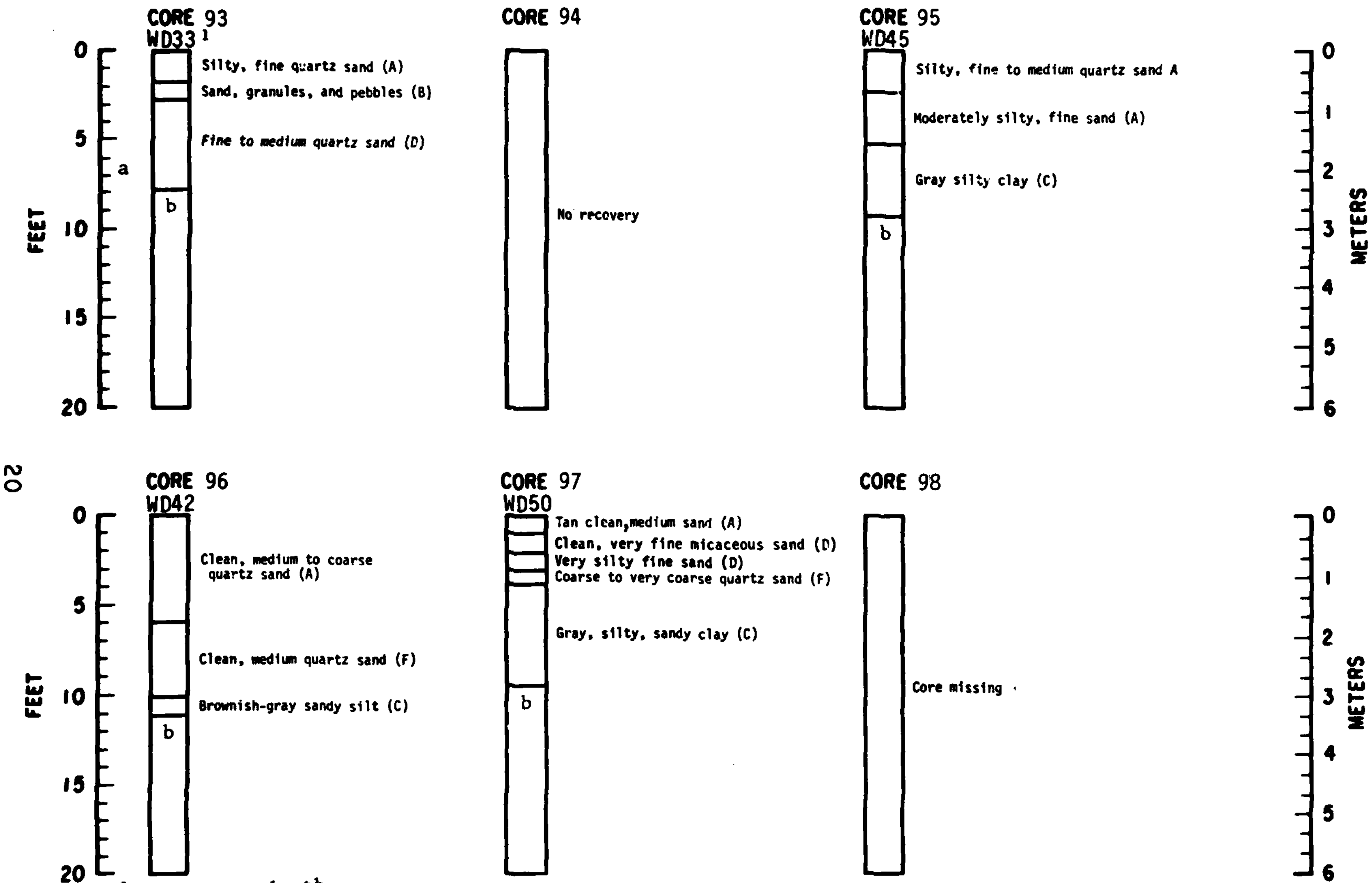
APPENDIX A

CORE SEDIMENT DESCRIPTIONS

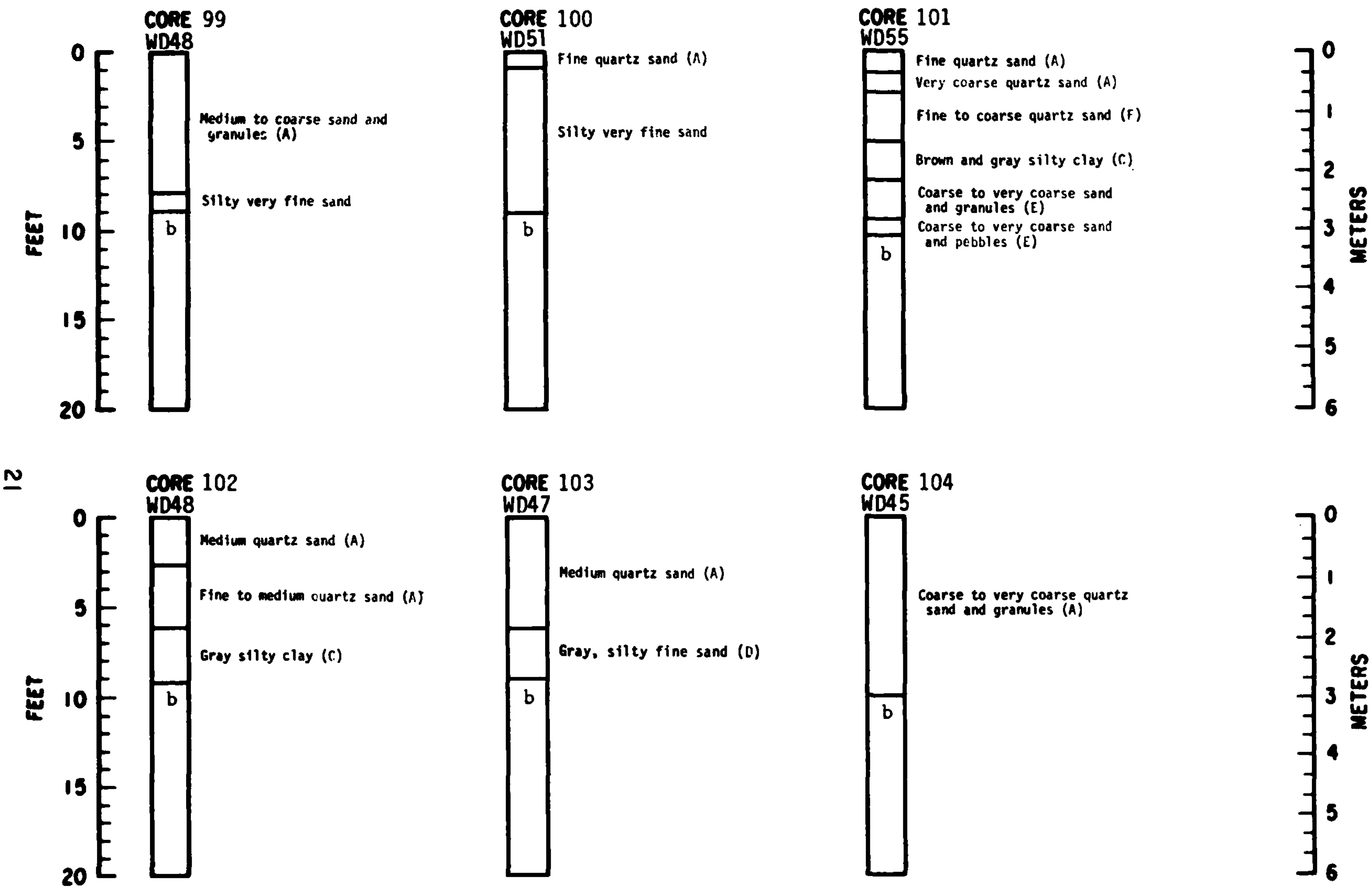
This appendix contains core sediment descriptions, based on both megascopic and microscopic examination, from sampling locations shown in Figure 2. Sediment color is based on dry samples.

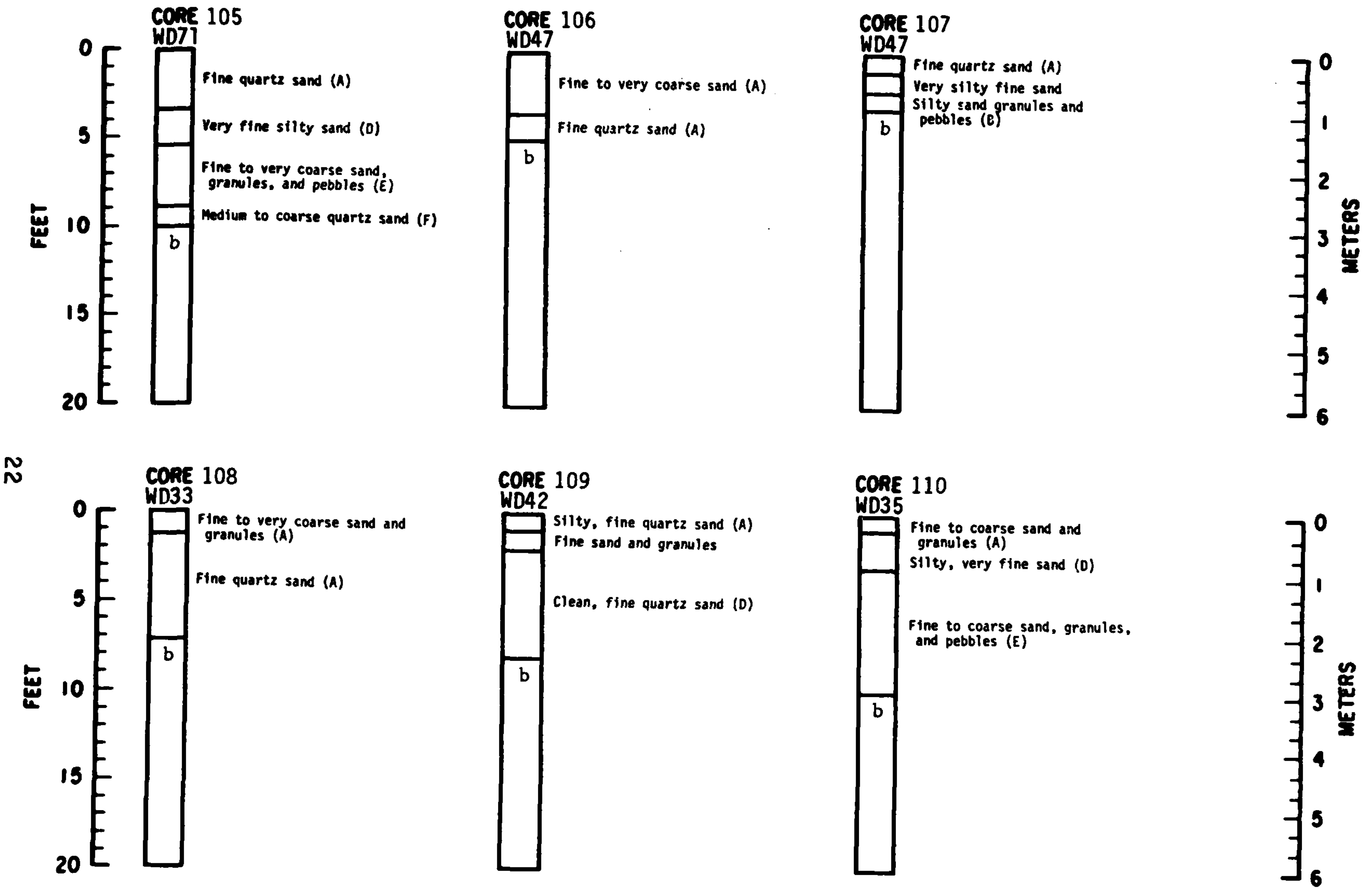
Sediment names are based on the following Wentworth classifications (see Table 1):

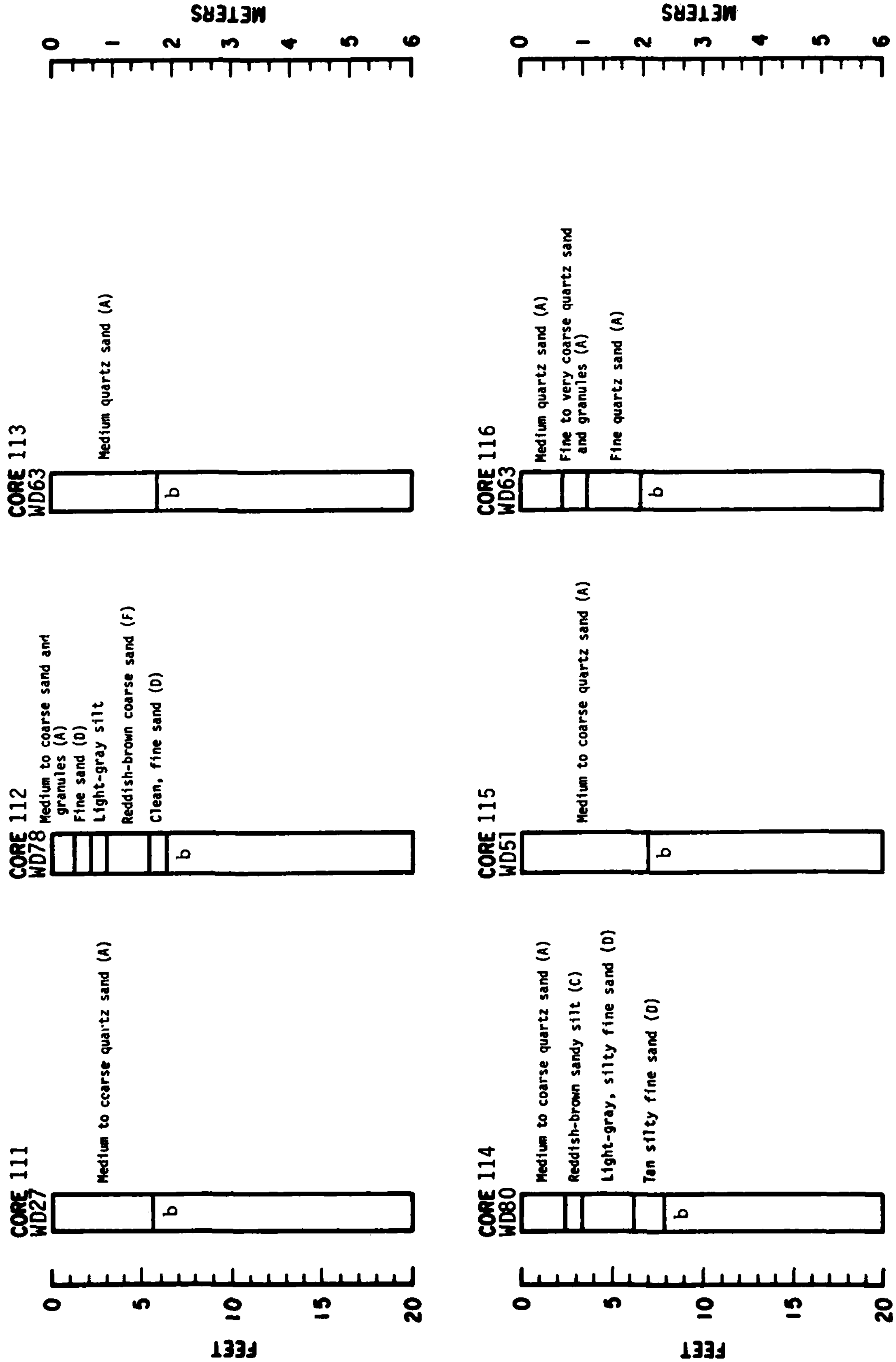
Sediment	Size (mm)	Phi
Gravel	>2	<-1
Very coarse sand	1.0 to 2.0	0 to -1
Coarse sand	0.5 to 1.0	1 to 0-
Medium sand	0.25 to 0.5	2 to 1-
Fine sand	0.125 to 0.25	3 to 2-
Very fine sand	0.0625 to 0.125	4 to 3-
Silt and mud	<0.0625	>4
Sorting terms		
Very well sorted		0.35
Well sorted		0.50
Moderately well sorted		0.80
Moderately sorted		1.40
Poorly sorted		2.00
Very poorly sorted		2.60
Extremely poorly sorted		

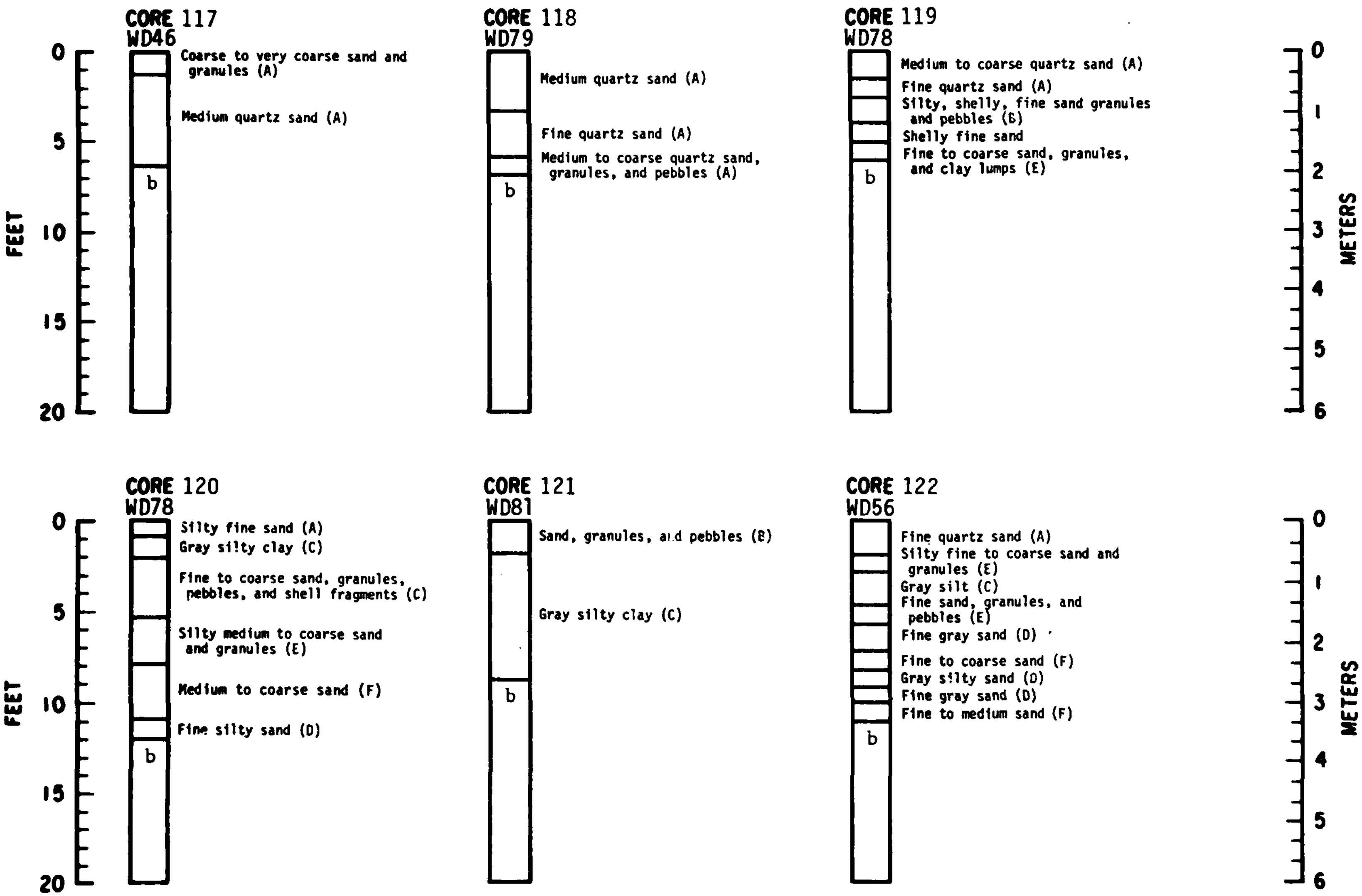


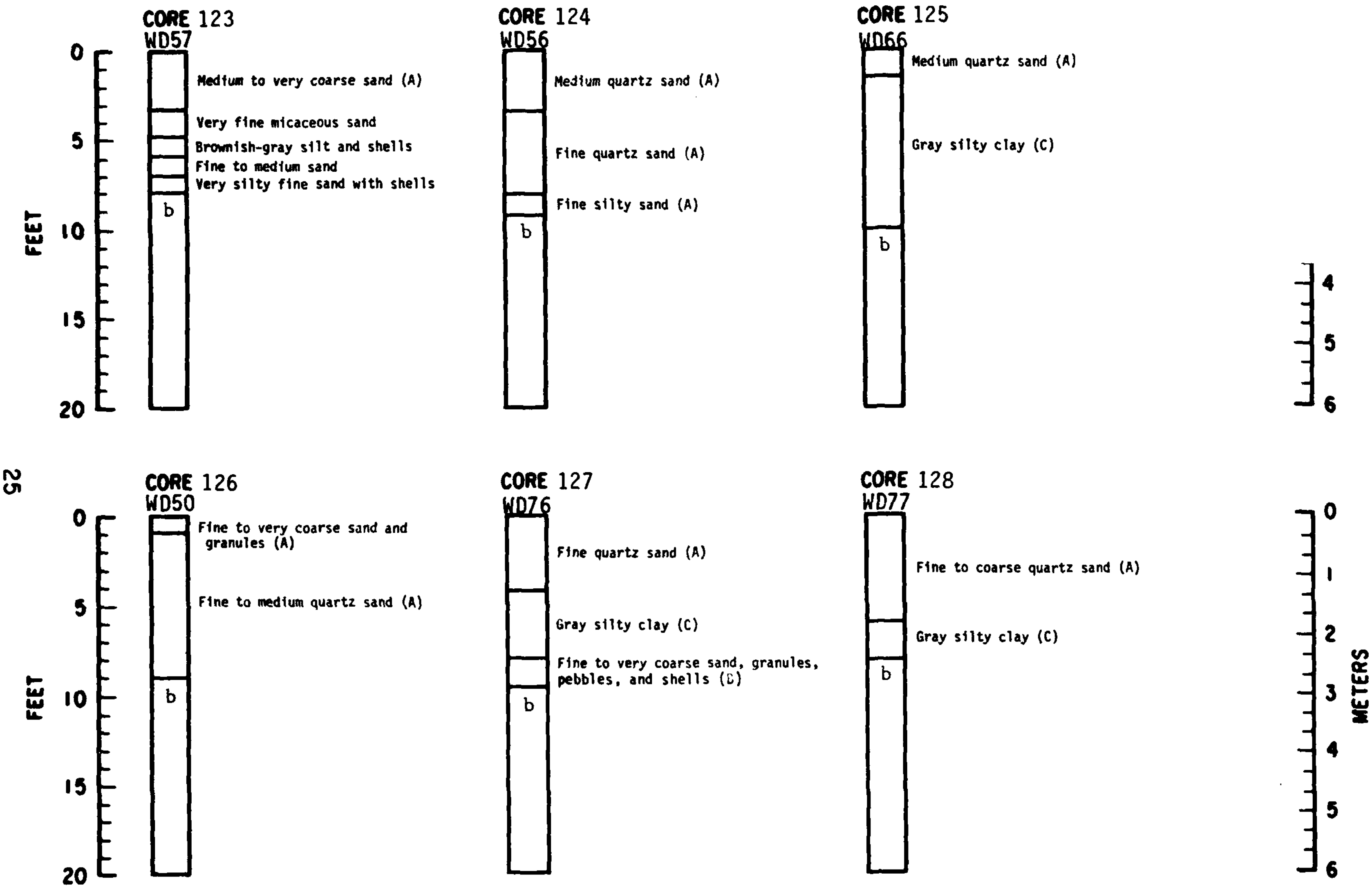
[1]WD = water depth

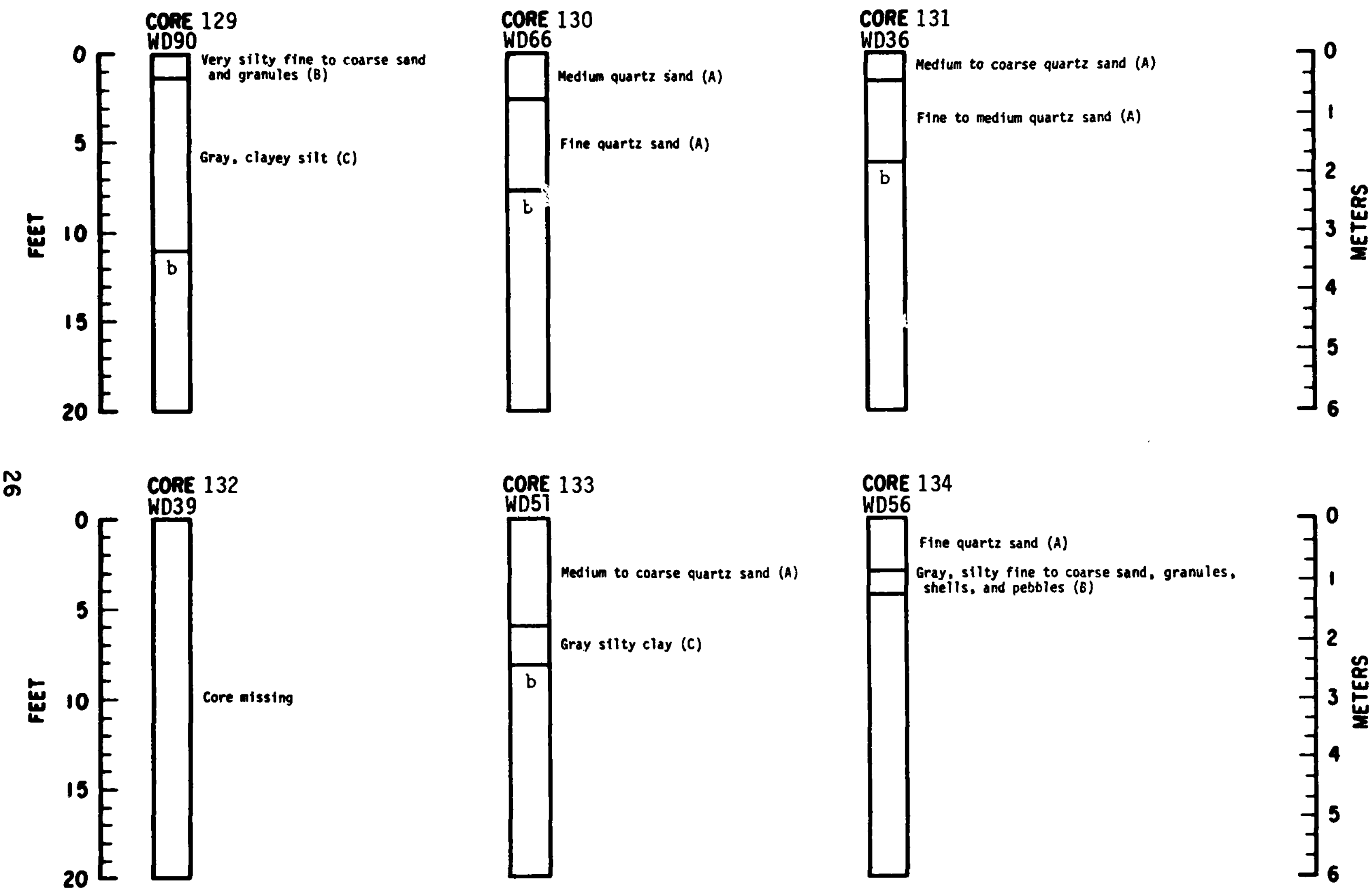

CORE 99
WD48
Medium to coarse sand and granules (A)
Silty very fine sand
b
CORE 100
WD51
Fine quartz sand (A)
Silty very fine sand
b
CORE 101
WD55
Fine quartz sand (A)
Very coarse quartz sand (A)
Fine to coarse quartz sand (F)
Brown and gray silty clay (C)
Coarse to very coarse sand and granules (E)
Coarse to very coarse sand and pebbles (E)
b
CORE 102
WD48
Medium quartz sand (A)
Fine to medium quartz sand (A)
Gray silty clay (C)
b
CORE 103
WD47
Medium quartz sand (A)
Gray, silty fine sand (D)
b
CORE 104
WD45
Coarse to very coarse quartz sand and granules (A)
b
FEET
0
5
10
15
20
METERS
0
1
2
3
4
5
6

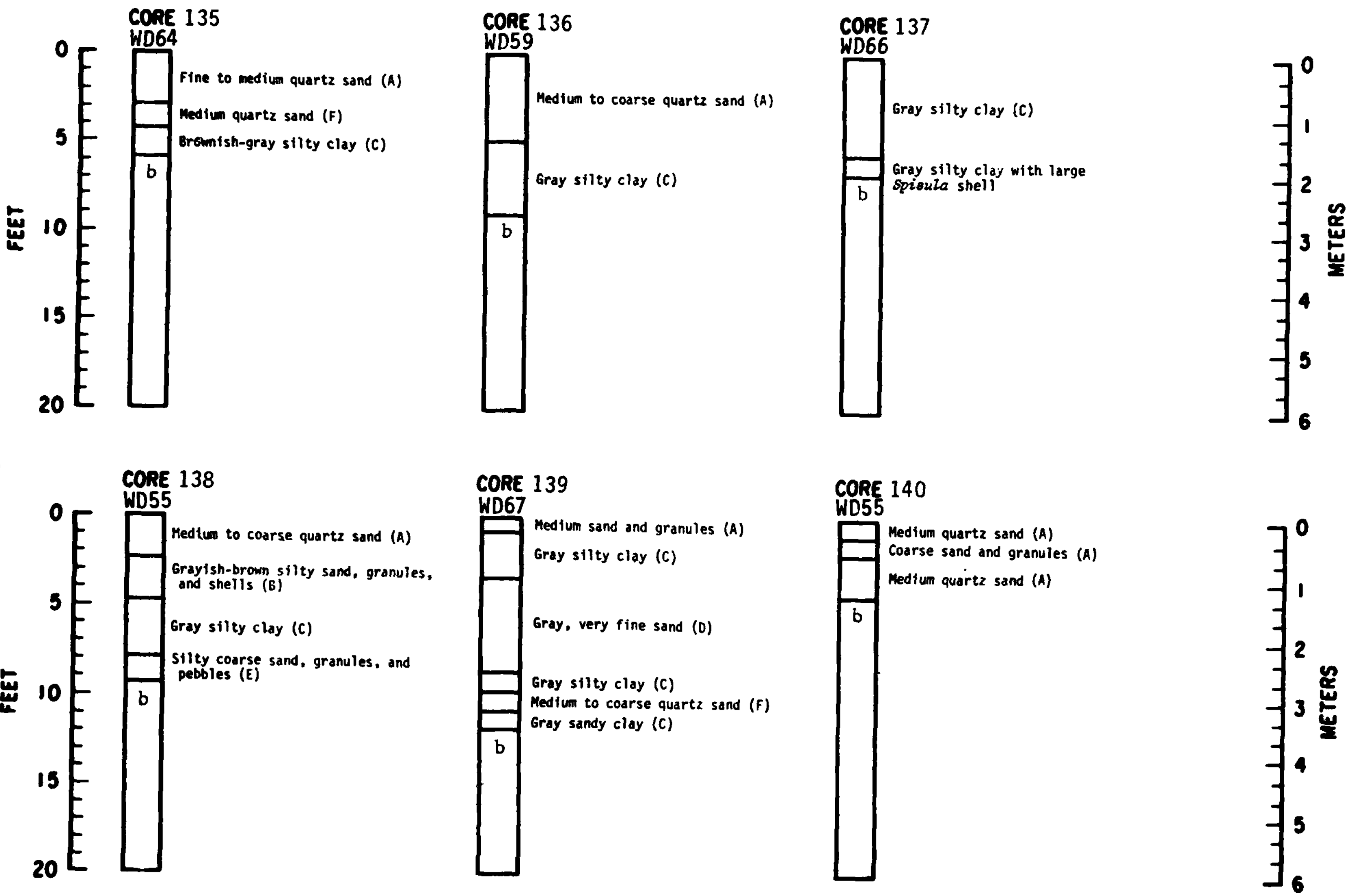

CORE 105
WD71
Fine quartz sand (A)
Very fine silty sand (D)
Fine to very coarse sand, granules, and pebbles (E)
Medium to coarse quartz sand (F)
b
CORE 106
WD47
Fine to very coarse sand (A)
Fine quartz sand (A)
b
CORE 107
WD47
Fine quartz sand (A)
Very silty fine sand
Silty sand granules and pebbles (B)
b
CORE 108
WD33
Fine to very coarse sand and granules (A)
Fine quartz sand (A)
b
CORE 109
WD42
Silty, fine quartz sand (A)
Fine sand and granules
Clean, fine quartz sand (D)
b
CORE 110
WD35
Fine to coarse sand and granules (A)
Silty, very fine sand (D)
Fine to coarse sand, granules, and pebbles (E)
b
FEET
0
5
10
15
20
METERS
0
1
2
3
4
5
6


CORE 111 WD27
Medium to coarse quartz sand (A)
b
CORE 112 WD78
Medium to coarse sand and granules (A)
Fine sand (D)
Light-gray silt
Reddish-brown coarse sand (F)
Clean, fine sand (D)
b
CORE 113 WD63
Medium quartz sand (A)
b
CORE 114 WD80
Medium to coarse quartz sand (A)
Reddish-brown sandy silt (C)
Light-gray, silty fine sand (D)
Tan silty fine sand (D)
b
CORE 115 WD51
Medium to coarse quartz sand (A)
b
CORE 116 WD63
Medium quartz sand (A)
Fine to very coarse quartz sand and granules (A)
Fine quartz sand (A)
b
FEET
0
5
10
15
20
METERS
0
1
2
3
4
5
6

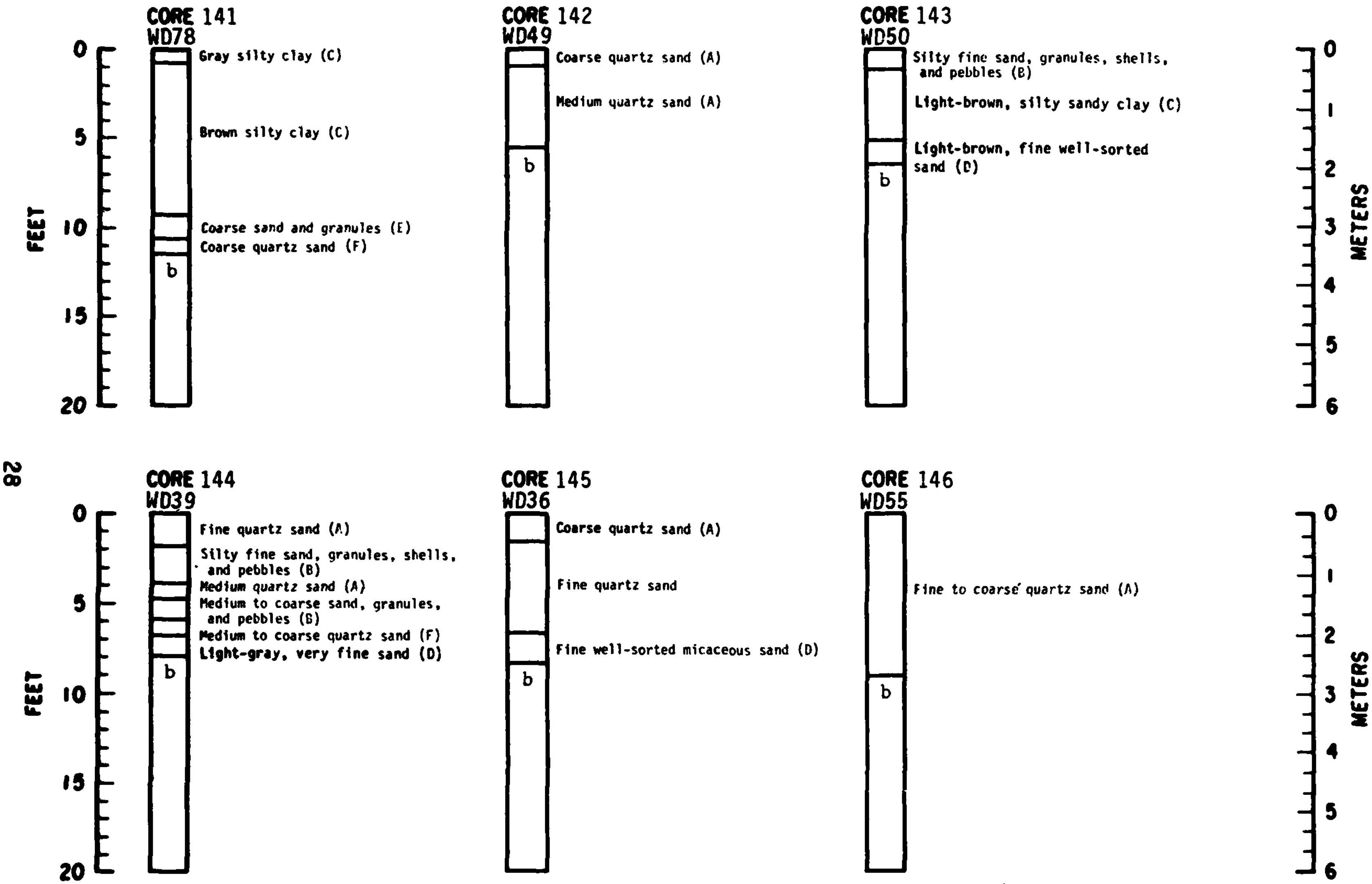

CORE 117
WD46
Coarse to very coarse sand and granules (A)
Medium quartz sand (A)
b
CORE 118
WD79
Medium quartz sand (A)
Fine quartz sand (A)
Medium to coarse quartz sand, granules, and pebbles (A)
b
CORE 119
WD78
Medium to coarse quartz sand (A)
Fine quartz sand (A)
Silty, shelly, fine sand granules and pebbles (B)
Shelly fine sand
Fine to coarse sand, granules, and clay lumps (E)
b
CORE 120
WD78
Silty fine sand (A)
Gray silty clay (C)
Fine to coarse sand, granules, pebbles, and shell fragments (C)
Silty medium to coarse sand and granules (E)
Medium to coarse sand (F)
Fine silty sand (D)
b
CORE 121
WD81
Sand, granules, and pebbles (E)
Gray silty clay (C)
b
CORE 122
WD56
Fine quartz sand (A)
Silty fine to coarse sand and granules (E)
Gray silt (C)
Fine sand, granules, and pebbles (E)
Fine gray sand (D)
Fine to coarse sand (F)
Gray silty sand (D)
Fine gray sand (D)
Fine to medium sand (F)
b
FEET
0
5
10
15
20
METERS
0
1
2
3
4
5
6


CORE 123
WD57
Medium to very coarse sand (A)
Very fine micaceous sand
Brownish-gray silt and shells
Fine to medium sand
Very silty fine sand with shells
b
CORE 124
WD56
Medium quartz sand (A)
Fine quartz sand (A)
Fine silty sand (A)
b
CORE 125
WD66
Medium quartz sand (A)
Gray silty clay (C)
b
CORE 126
WD50
Fine to very coarse sand and granules (A)
Fine to medium quartz sand (A)
b
CORE 127
WD76
Fine quartz sand (A)
Gray silty clay (C)
Fine to very coarse sand, granules, pebbles, and shells (C)
b
CORE 128
WD77
Fine to coarse quartz sand (A)
Gray silty clay (C)
b
FEET
0
5
10
15
20
METERS
0
1
2
3
4
5
6

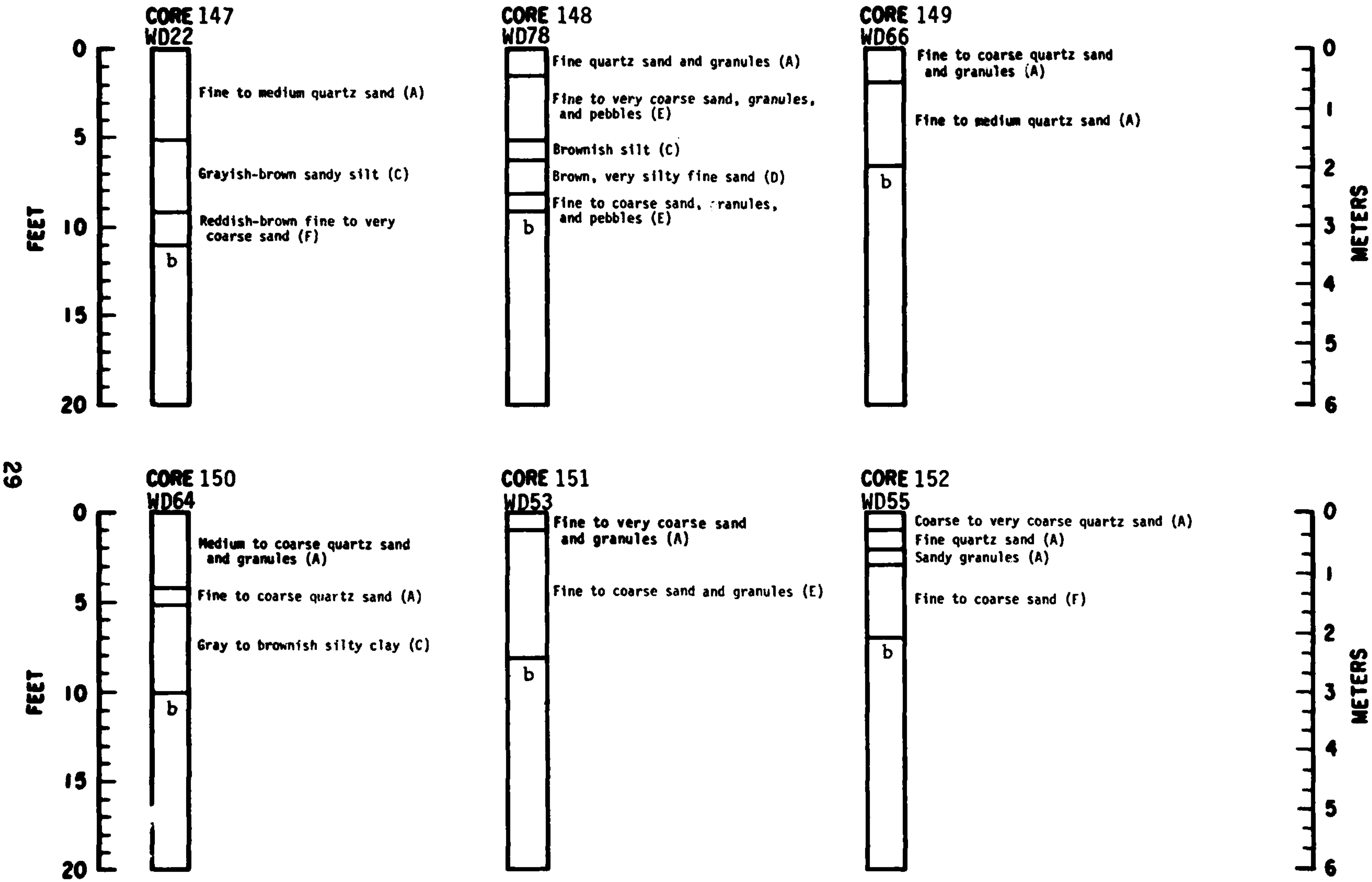

CORE 129
WD90
Very silty fine to coarse sand and granules (B)
Gray, clayey silt (C)
b
CORE 130
WD66
Medium quartz sand (A)
Fine quartz sand (A)
b
CORE 131
WD36
Medium to coarse quartz sand (A)
Fine to medium quartz sand (A)
b
CORE 132
WD39
Core missing
CORE 133
WD51
Medium to coarse quartz sand (A)
Gray silty clay (C)
b
CORE 134
WD56
Fine quartz sand (A)
Gray, silty fine to coarse sand, granules, shells, and pebbles (B)
FEET
0
5
10
15
20
METERS
0
1
2
3
4
5
6

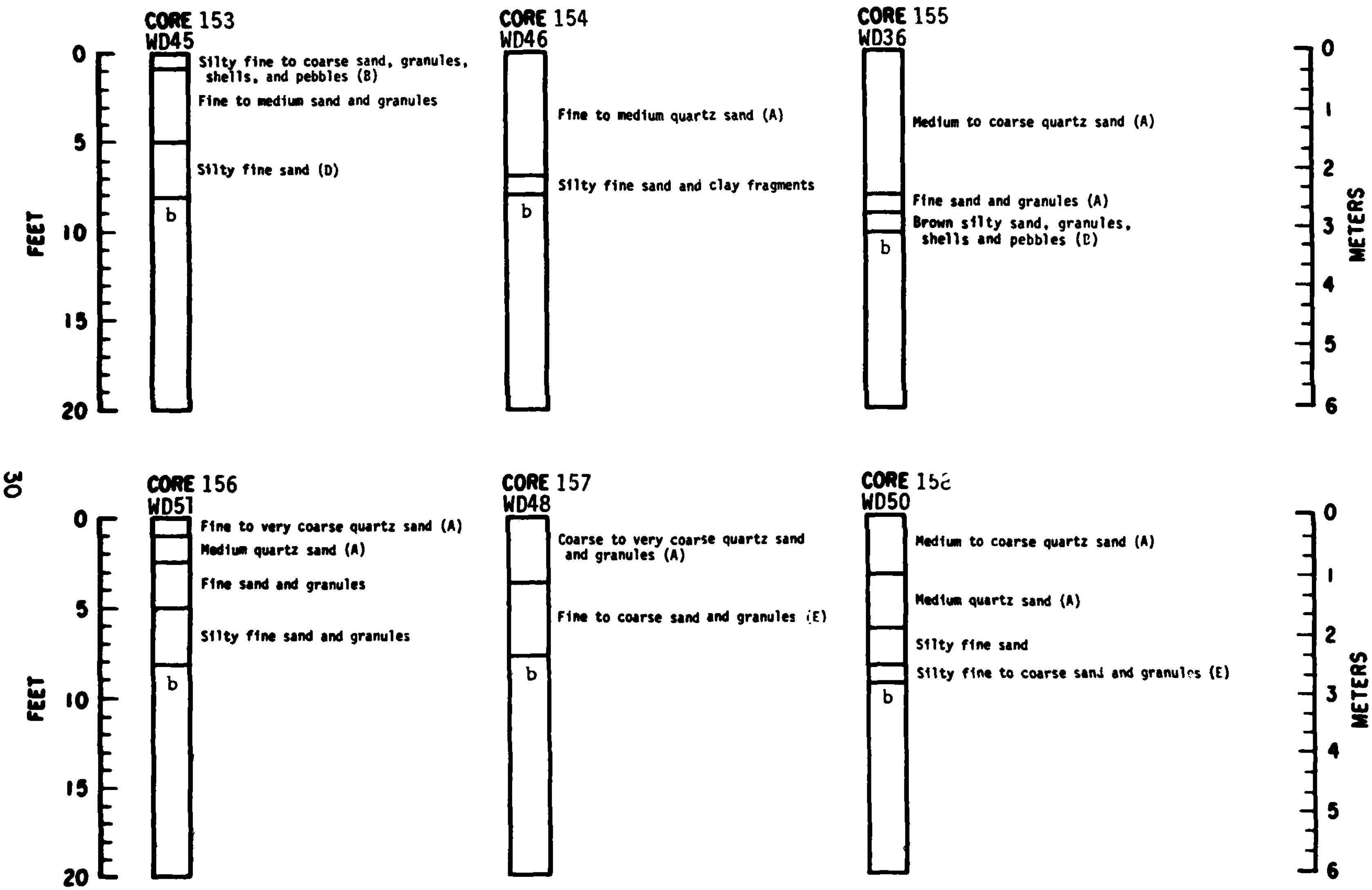


CORE 135
WD64
Fine to medium quartz sand (A)
Medium quartz sand (F)
Brownish-gray silty clay (C)
b
CORE 136
WD59
Medium to coarse quartz sand (A)
Gray silty clay (C)
b
CORE 137
WD66
Gray silty clay (C)
Gray silty clay with large *Spisula* shell
b
CORE 138
WD55
Medium to coarse quartz sand (A)
Grayish-brown silty sand, granules, and shells (B)
Gray silty clay (C)
Silty coarse sand, granules, and pebbles (E)
b
CORE 139
WD67
Medium sand and granules (A)
Gray silty clay (C)
Gray, very fine sand (D)
Gray silty clay (C)
Medium to coarse quartz sand (F)
Gray sandy clay (C)
b
CORE 140
WD55
Medium quartz sand (A)
Coarse sand and granules (A)
Medium quartz sand (A)
b
FEET
0
5
10
15
20
METERS
0
1
2
3
4
5
6

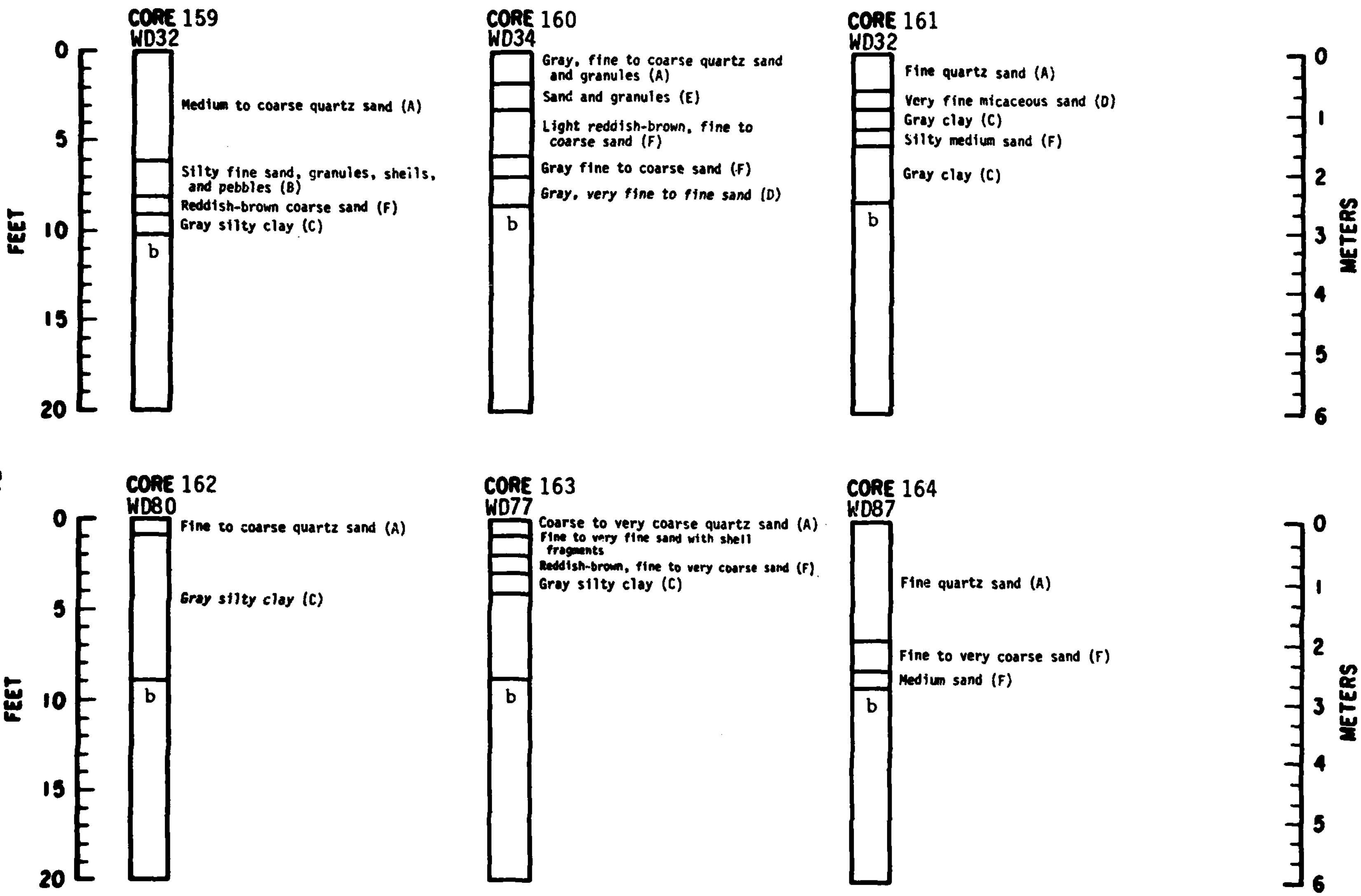


CORE 141
WD78
Gray silty clay (C)
Brown silty clay (C)
Coarse sand and granules (E)
Coarse quartz sand (F)
b
CORE 142
WD49
Coarse quartz sand (A)
Medium quartz sand (A)
b
CORE 143
WD50
Silty fine sand, granules, shells, and pebbles (B)
Light-brown, silty sandy clay (C)
Light-brown, fine well-sorted sand (D)
b
CORE 144
WD39
Fine quartz sand (A)
Silty fine sand, granules, shells, and pebbles (B)
Medium quartz sand (A)
Medium to coarse sand, granules, and pebbles (B)
Medium to coarse quartz sand (F)
Light-gray, very fine sand (D)
b
CORE 145
WD36
Coarse quartz sand (A)
Fine quartz sand
Fine well-sorted micaceous sand (D)
b
CORE 146
WD55
Fine to coarse quartz sand (A)
b
FEET
0
5
10
15
20
METERS
0
1
2
3
4
5
6

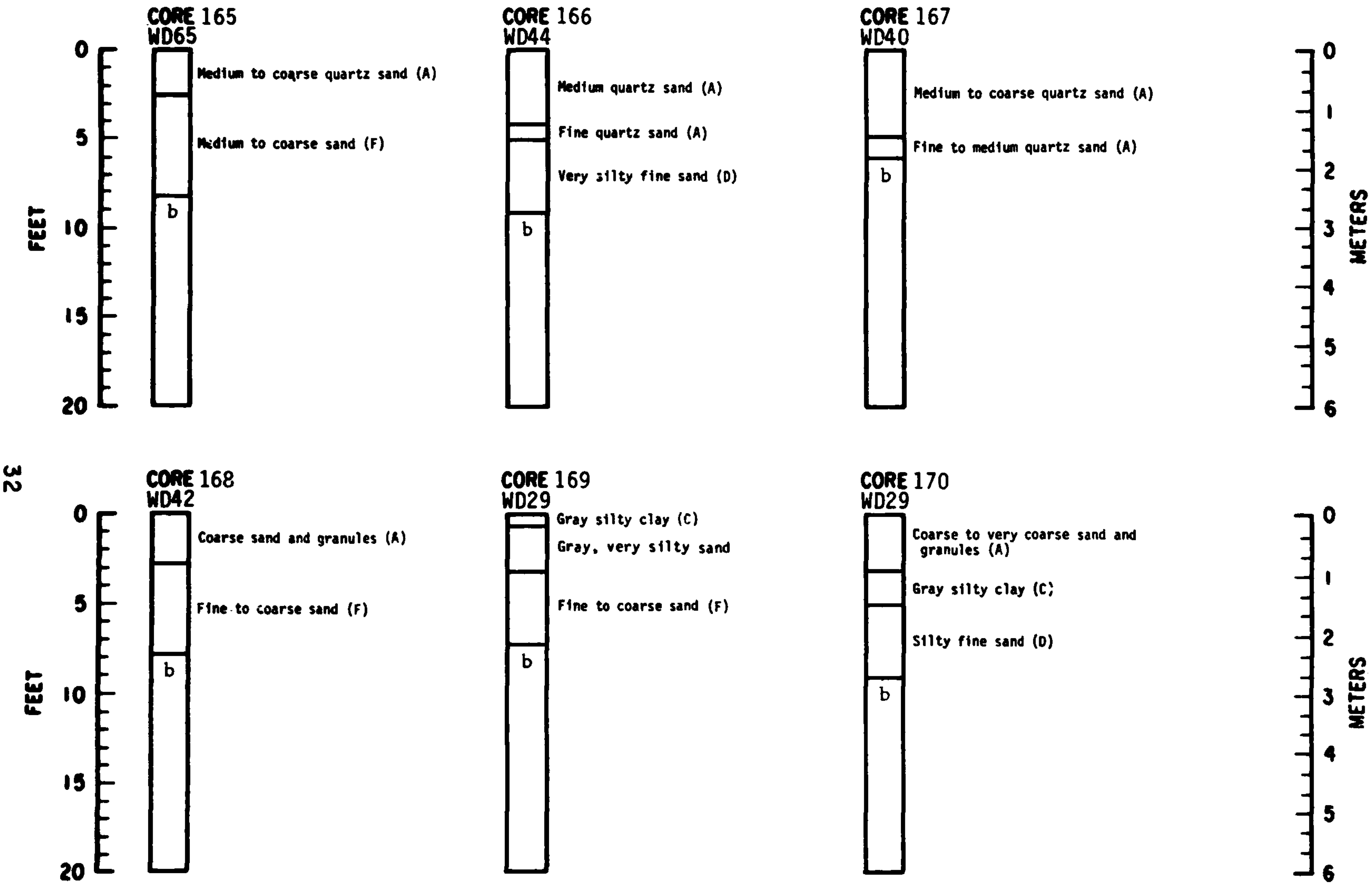

CORE 147
WD22
Fine to medium quartz sand (A)
Grayish-brown sandy silt (C)
Reddish-brown fine to very coarse sand (F)
b
CORE 148
WD78
Fine quartz sand and granules (A)
Fine to very coarse sand, granules, and pebbles (E)
Brownish silt (C)
Brown, very silty fine sand (D)
Fine to coarse sand, granules, and pebbles (E)
b
CORE 149
WD66
Fine to coarse quartz sand and granules (A)
Fine to medium quartz sand (A)
b
CORE 150
WD64
Medium to coarse quartz sand and granules (A)
Fine to coarse quartz sand (A)
Gray to brownish silty clay (C)
b
CORE 151
WD53
Fine to very coarse sand and granules (A)
Fine to coarse sand and granules (E)
b
CORE 152
WD55
Coarse to very coarse quartz sand (A)
Fine quartz sand (A)
Sandy granules (A)
Fine to coarse sand (F)
b
FEET
0
5
10
15
20
METERS
0
1
2
3
4
5
6

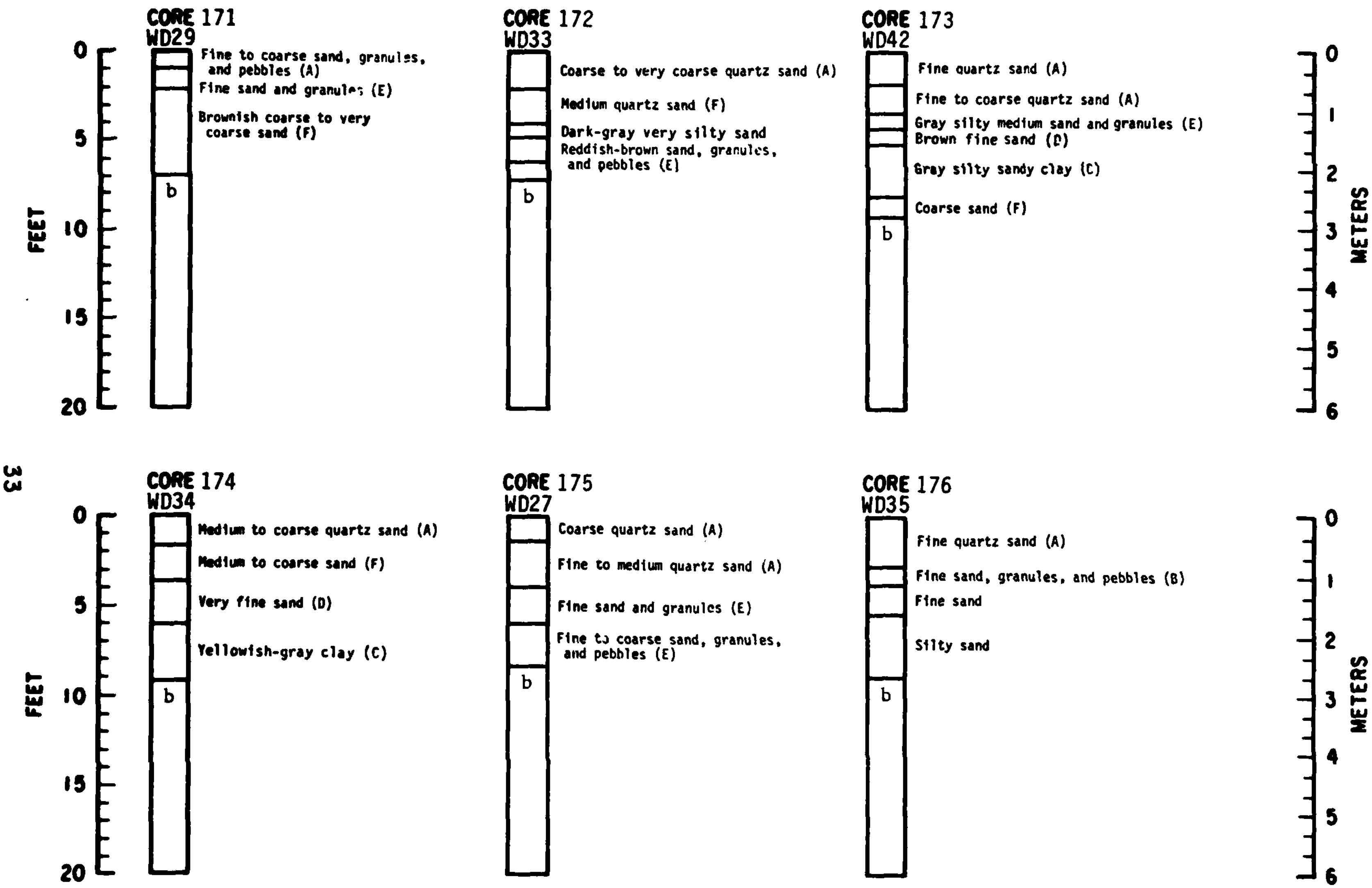


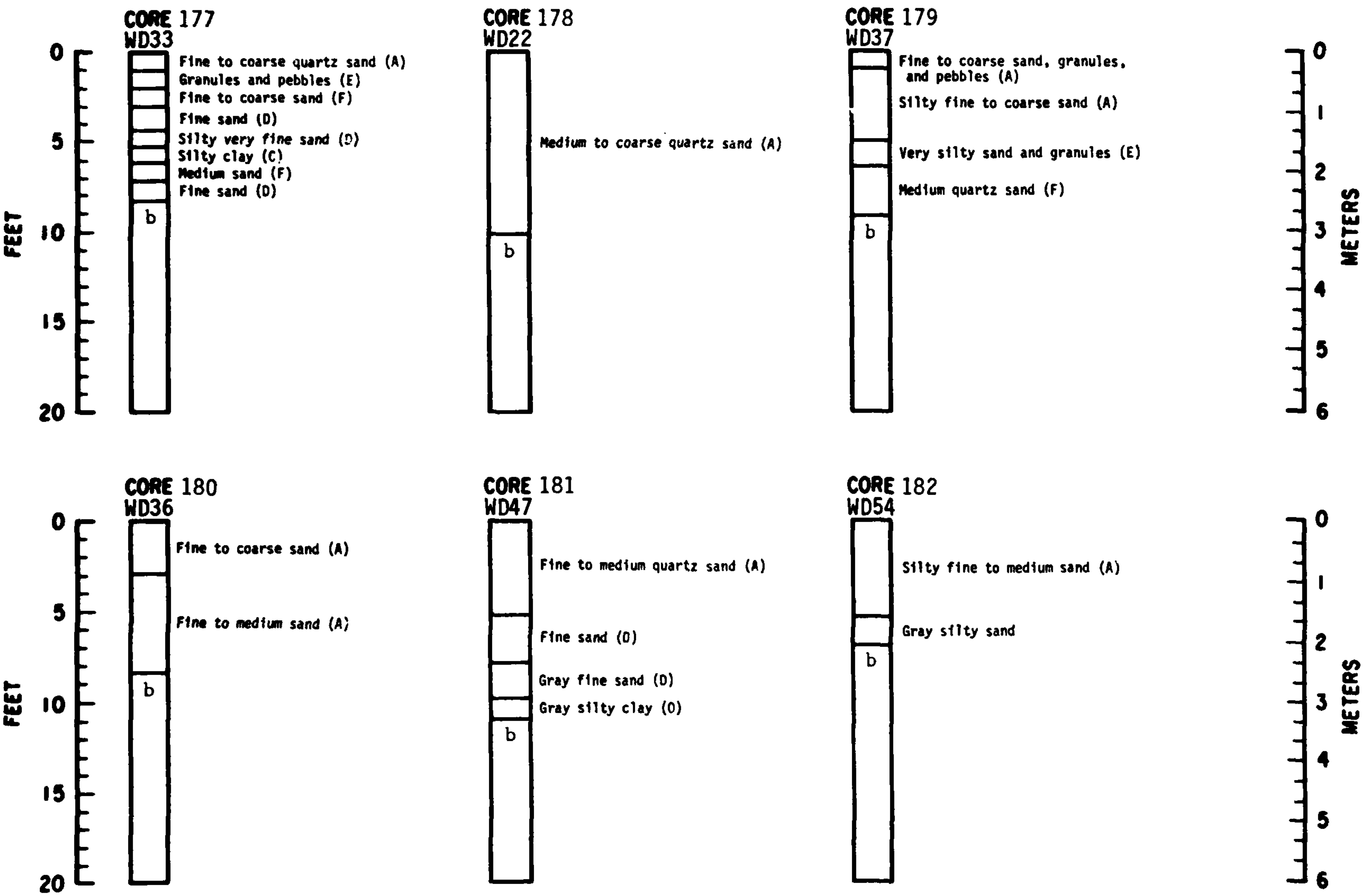
CORE 153
WD45
Silty fine to coarse sand, granules, shells, and pebbles (B)
Fine to medium sand and granules
Silty fine sand (D)
b
CORE 154
WD46
Fine to medium quartz sand (A)
Silty fine sand and clay fragments
b
CORE 155
WD36
Medium to coarse quartz sand (A)
Fine sand and granules (A)
Brown silty sand, granules, shells and pebbles (D)
b
CORE 156
WD51
Fine to very coarse quartz sand (A)
Medium quartz sand (A)
Fine sand and granules
Silty fine sand and granules
b
CORE 157
WD48
Coarse to very coarse quartz sand and granules (A)
Fine to coarse sand and granules (E)
b
CORE 158
WD50
Medium to coarse quartz sand (A)
Medium quartz sand (A)
Silty fine sand
Silty fine to coarse sand and granules (E)
b
FEET
0
5
10
15
20
METERS
0
1
2
3
4
5
6

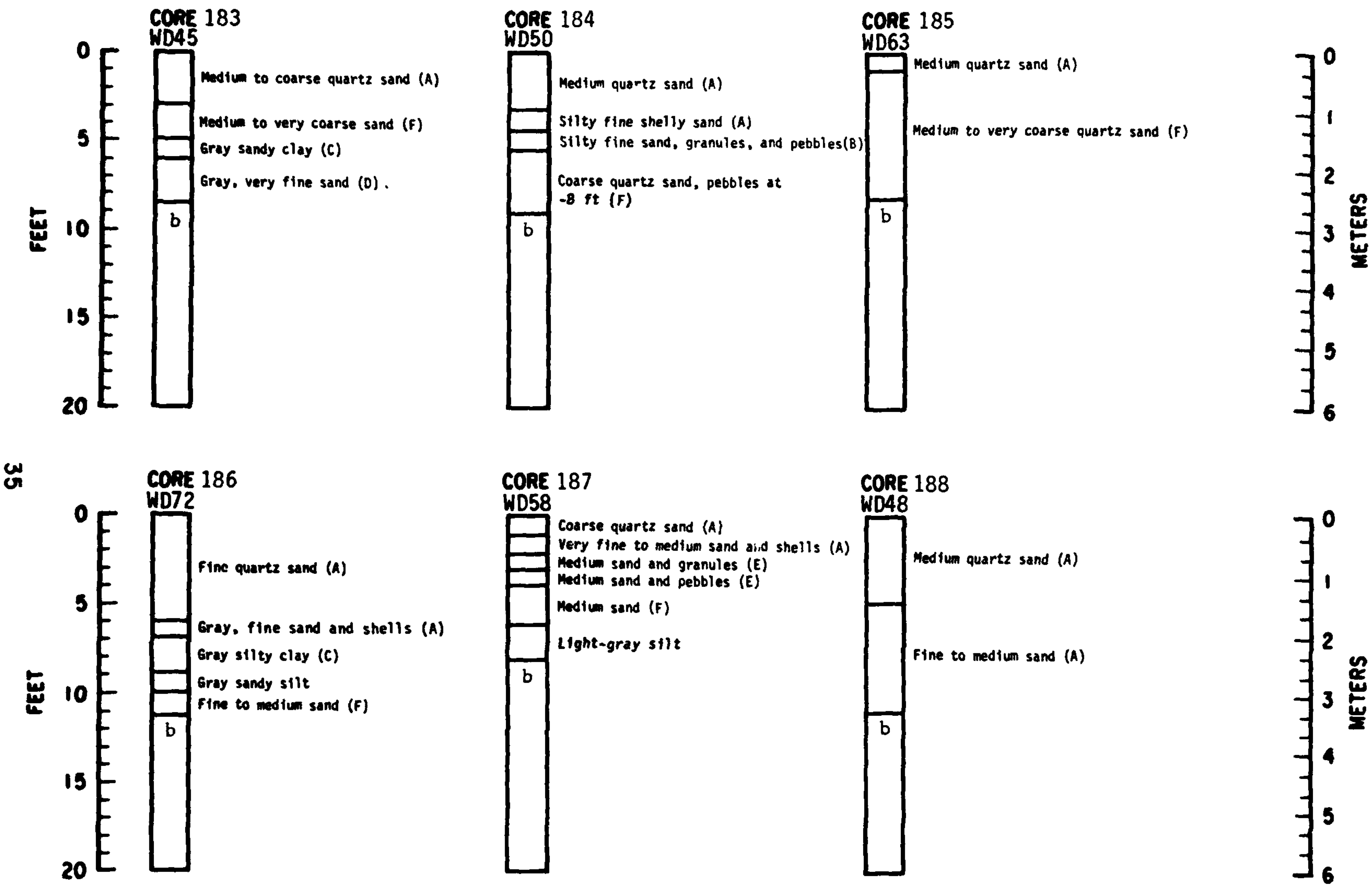


CORE 159
WD32
Medium to coarse quartz sand (A)
Silty fine sand, granules, sheils, and pebbles (B)
Reddish-brown coarse sand (F)
Gray silty clay (C)
b
CORE 160
WD34
Gray, fine to coarse quartz sand and granules (A)
Sand and granules (E)
Light reddish-brown, fine to coarse sand (F)
Gray fine to coarse sand (F)
Gray, very fine to fine sand (D)
b
CORE 161
WD32
Fine quartz sand (A)
Very fine micaceous sand (D)
Gray clay (C)
Silty medium sand (F)
Gray clay (C)
b
CORE 162
WD80
Fine to coarse quartz sand (A)
Gray silty clay (C)
b
CORE 163
WD77
Coarse to very coarse quartz sand (A)
Fine to very fine sand with shell fragments
Reddish-brown, fine to very coarse sand (F)
Gray silty clay (C)
b
CORE 164
WD87
Fine quartz sand (A)
Fine to very coarse sand (F)
Medium sand (F)
b
FEET
0
5
10
15
20
METERS
0
1
2
3
4
5
6

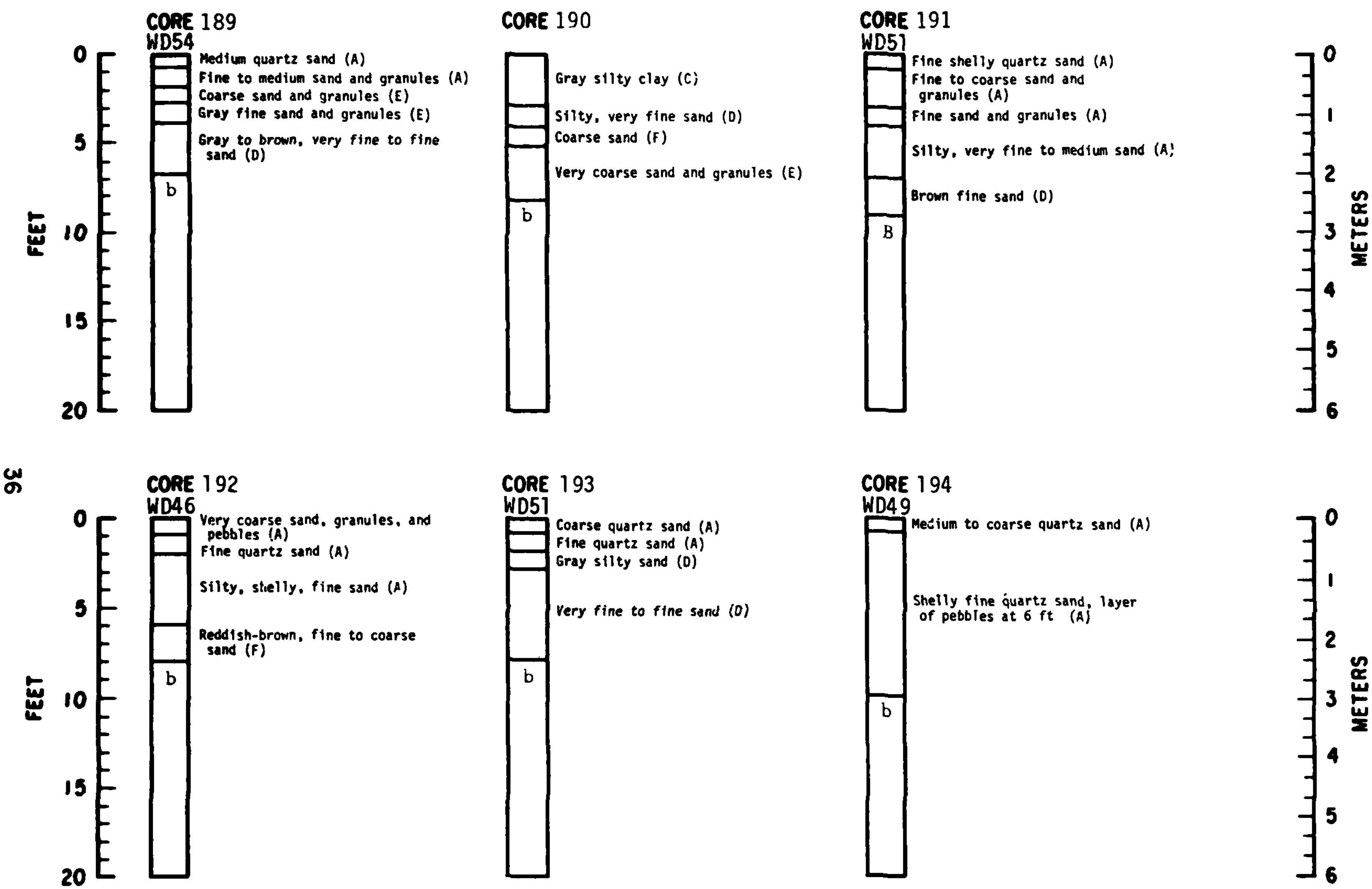

CORE 165
WD65
Medium to coarse quartz sand (A)
Medium to coarse sand (F)
b
CORE 166
WD44
Medium quartz sand (A)
Fine quartz sand (A)
Very silty fine sand (D)
b
CORE 167
WD40
Medium to coarse quartz sand (A)
Fine to medium quartz sand (A)
b
CORE 168
WD42
Coarse sand and granules (A)
Fine to coarse sand (F)
b
CORE 169
WD29
Gray silty clay (C)
Gray, very silty sand
Fine to coarse sand (F)
b
CORE 170
WD29
Coarse to very coarse sand and granules (A)
Gray silty clay (C)
Silty fine sand (D)
b
FEET
0
5
10
15
20
METERS
0
1
2
3
4
5
6

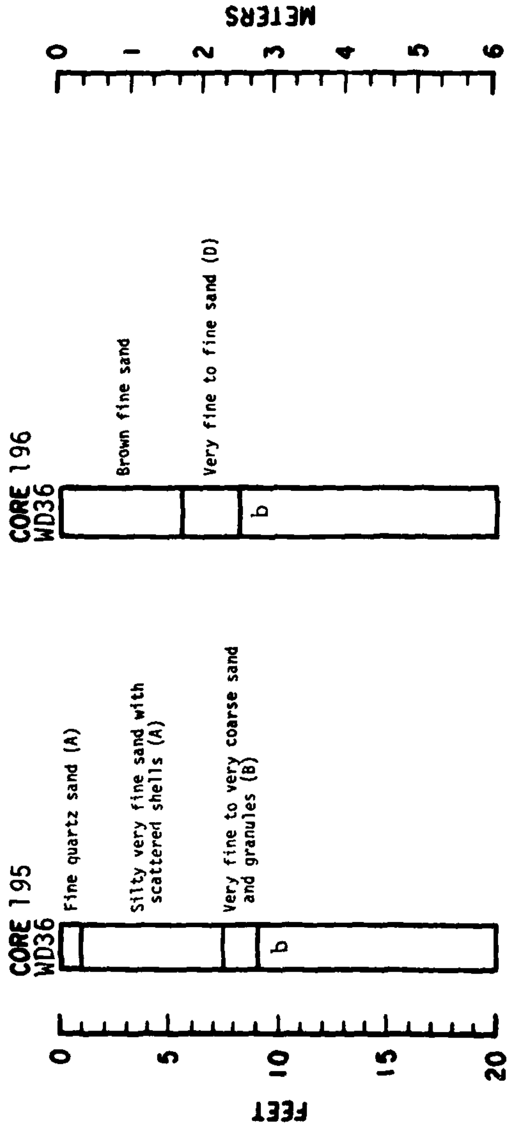

CORE 171
WD29
Fine to coarse sand, granules, and pebbles (A)
Fine sand and granules (E)
Brownish coarse to very coarse sand (F)
b
CORE 172
WD33
Coarse to very coarse quartz sand (A)
Medium quartz sand (F)
Dark-gray very silty sand
Reddish-brown sand, granules, and pebbles (E)
b
CORE 173
WD42
Fine quartz sand (A)
Fine to coarse quartz sand (A)
Gray silty medium sand and granules (E)
Brown fine sand (D)
Gray silty sandy clay (C)
Coarse sand (F)
b
CORE 174
WD34
Medium to coarse quartz sand (A)
Medium to coarse sand (F)
Very fine sand (D)
Yellowish-gray clay (C)
b
CORE 175
WD27
Coarse quartz sand (A)
Fine to medium quartz sand (A)
Fine sand and granules (E)
Fine to coarse sand, granules, and pebbles (E)
b
CORE 176
WD35
Fine quartz sand (A)
Fine sand, granules, and pebbles (B)
Fine sand
Silty sand
b
FEET
0
5
10
15
20
METERS
0
1
2
3
4
5
6


CORE 177
WD33
Fine to coarse quartz sand (A)
Granules and pebbles (E)
Fine to coarse sand (F)
Fine sand (D)
Silty very fine sand (D)
Silty clay (C)
Medium sand (F)
Fine sand (D)
b
CORE 178
WD22
Medium to coarse quartz sand (A)
b
CORE 179
WD37
Fine to coarse sand, granules, and pebbles (A)
Silty fine to coarse sand (A)
Very silty sand and granules (E)
Medium quartz sand (F)
b
CORE 180
WD36
Fine to coarse sand (A)
Fine to medium sand (A)
b
CORE 181
WD47
Fine to medium quartz sand (A)
Fine sand (D)
Gray fine sand (D)
Gray silty clay (D)
b
CORE 182
WD54
Silty fine to medium sand (A)
Gray silty sand
b
FEET
0
5
10
15
20
METERS
0
1
2
3
4
5
6



CORE 183
WD45
Medium to coarse quartz sand (A)
Medium to very coarse sand (F)
Gray sandy clay (C)
Gray, very fine sand (D).
b
CORE 184
WD50
Medium quartz sand (A)
Silty fine shelly sand (A)
Silty fine sand, granules, and pebbles(B)
Coarse quartz sand, pebbles at
-8 ft (F)
b
CORE 185
WD63
Medium quartz sand (A)
Medium to very coarse quartz sand (F)
b
CORE 186
WD72
Fine quartz sand (A)
Gray, fine sand and shells (A)
Gray silty clay (C)
Gray sandy silt
Fine to medium sand (F)
b
CORE 187
WD58
Coarse quartz sand (A)
Very fine to medium sand and shells (A)
Medium sand and granules (E)
Medium sand and pebbles (E)
Medium sand (F)
Light-gray silt
b
CORE 188
WD48
Medium quartz sand (A)
Fine to medium sand (A)
b
FEET
0
5
10
15
20
METERS
0
1
2
3
4
5
6


CORE 189
WD54
Medium quartz sand (A)
Fine to medium sand and granules (A)
Coarse sand and granules (E)
Gray fine sand and granules (E)
Gray to brown, very fine to fine sand (D)
b
CORE 190
Gray silty clay (C)
Silty, very fine sand (D)
Coarse sand (F)
Very coarse sand and granules (E)
b
CORE 191
WD51
Fine shelly quartz sand (A)
Fine to coarse sand and granules (A)
Fine sand and granules (A)
Silty, very fine to medium sand (A)
Brown fine sand (D)
B
CORE 192
WD46
Very coarse sand, granules, and pebbles (A)
Fine quartz sand (A)
Silty, shelly, fine sand (A)
Reddish-brown, fine to coarse sand (F)
b
CORE 193
WD51
Coarse quartz sand (A)
Fine quartz sand (A)
Gray silty sand (D)
Very fine to fine sand (D)
b
CORE 194
WD49
Medium to coarse quartz sand (A)
Shelly fine quartz sand, layer of pebbles at 6 ft (A)
b
FEET
0
5
10
15
20
METERS
0
1
2
3
4
5
6



METERS
0
1
2
3
4
5
6
CORE 196
WD36
Brown fine sand
Very fine to fine sand (D)
b
CORE 195
WD36
Fine quartz sand (A)
Silty very fine sand with scattered shells (A)
Very fine to very coarse sand and granules (B)
b
0
5
10
15
20
FEET

APPENDIX B

GRANULOMETRIC DATA AND CUMULATIVE CURVE PLOTS

This appendix contains the results of CERC's Rapid Sediment Analyzer (RSA) size analyses of 258 sediment samples from 104 cores (Table B-1) in the study area (see Fig. 2). Analyses are based on sand-size fractions only.

The samples are identified by core number and sample interval below the top of the core. Specific locations of the samples from each core are given in Appendix A.

Experience has shown that grain-size values from RSA analyses are consistent and slightly coarser than results of dry sieve analyses of identical samples. To relate these RSA data to other sieve data, empirical relations for converting RSA means and standard deviation to sieve analyses equivalents have been determined. The relationships, developed from RSA and sieve analyses at a 0.25-phi interval, are:

$$\text{mean: } \bar{X}_{\phi\text{sieve}} = 1.0735\ \bar{X}_{\phi\text{RSA}} + 0.1876$$

RSA standard deviation values may be converted to sieve sorting equivalents by the formula:

$$\text{standard deviation: } \sigma_{\phi}\text{ sieve} = 1.4535\ \sigma_{\phi}\text{ RSA} - 0.146$$

Table B-1. Results of RSA size analyses of 258 sediment samples.

Core	Interval (ft)	Mean (phi)	Mean (mm)	Median (phi)	Median (mm)	Std. dev. (phi)	Std. dev. (mm)
93	Top	2.72	0.152	2.55	0.170	0.40	1.322
94	No data						
95	Top	1.20	0.436	1.07	0.475	0.94	1.915
96	Top	1.07	0.476	0.93	0.525	0.59	1.505
96	-3	1.41	0.376	1.32	0.401	0.55	1.464
96	-6	1.20	0.435	1.17	0.444	0.64	1.558
96	-8	1.66	0.310	1.60	0.330	0.44	1.357
96	11	1.91	0.266	1.87	0.274	0.52	1.434
97	Top	1.23	0.426	1.23	0.426	0.53	1.444
97	-2	2.71	0.153	3.44	0.092	1.03	2.042
97	-3	0.68	0.624	0.50	0.707	0.79	1.729
98	No data						
99	Top	0.83	0.563	0.73	0.603	0.64	1.558
99	-3	1.67	0.314	1.66	0.316	0.42	1.338
99	-6	1.02	0.493	1.39	0.382	0.90	1.866
99	-8	1.65	0.319	1.81	0.285	1.09	2.219
99	8.7	2.61	0.164	2.57	0.168	0.60	1.516
100	Top	2.23	0.213	2.25	0.210	0.47	1.385
100	-4	2.78	0.146	3.82	0.071	0.84	1.790
100	-8	2.96	1.290	No data		0.96	1.945
101	Top	1.90	0.268	1.86	0.275	0.98	1.967
102	Top	1.23	0.426	1.17	0.444	0.47	0.721
102	-3	1.37	0.386	1.30	0.406	0.57	0.673
102	-5	1.48	0.358	1.66	0.316	0.71	0.611
103	Top	1.05	0.482	1.06	0.479	0.47	0.721
103	-3	1.20	0.435	1.22	0.429	0.53	0.692
104	Top	0.65	0.637	0.59	0.664	0.72	0.607
104	-3	0.72	0.607	0.71	0.611	0.54	0.687
104	-6	0.46	0.726	0.54	0.687	0.68	0.624
105	Top	1.88	0.271	1.79	0.290	0.52	1.431
106	Top	0.82	0.566	0.55	0.685	0.84	1.788
106	-4	1.56	0.340	1.64	0.321	1.12	0.340
107	Top	2.45	0.183	2.73	0.151	0.82	1.765
108	Top	1.68	0.312	1.65	0.319	0.75	1.678
108	-3	1.89	0.270	1.84	0.279	0.86	1.819
108	[illegible]	2.46	0.181	2.40	0.790	0.48	1.393
109	Top	2.40	0.190	2.47	0.181	0.90	1.862
109	-4	2.25	0.210	2.00	0.250	0.67	1.593
109	-8	2.19	0.220	2.10	0.233	.45	1.367
110	Top	0.96	0.514	0.94	0.521	0.94	0.521
110	-2	2.61	0.163	3.34	0.098	0.79	0.578
110	-4	1.00	0.500	0.94	0.528	0.83	0.562
110	-6	0.97	0.510	0.77	0.586	1.09	0.469
110	-10	0.83	0.562	0.70	0.615	0.80	0.574
111	Top	0.99	0.503	0.96	0.514	0.25	0.840
111	-3	0.80	0.574	0.73	0.602	0.36	0.779
111	-5	1.12	0.460	1.04	0.486	0.27	0.829
112	Top	1.25	0.421	1.16	0.447	0.81	1.753
112	-2	1.77	0.293	1.50	0.354	0.89	1.850
112	-6	2.10	0.233	2.08	0.237	0.76	1.198
113	Top	1.30	0.406	1.22	0.429	0.42	0.747
113	-3	1.27	0.414	1.10	0.466	0.47	0.721
113	-6	1.55	0.341	1.43	0.371	0.37	0.773
114	Top	2.09	0.235	1.98	0.253	0.83	1.773
114	-6	2.50	0.177	2.35	0.196	0.61	1.526
115	Top	1.20	0.435	1.03	0.489	0.40	0.757
115	-4	1.12	0.460	1.06	0.479	0.49	0.712
115	-7	1.49	0.356	1.35	0.392	0.44	0.737
116	Top	1.47	0.360	1.36	0.389	0.42	0.747
116	-3	0.14	0.907	0.00	1.000	0.76	0.590
116	-6	2.13	0.228	2.09	0.234	0.48	0.716
117	Top	0.78	0.582	0.59	0.664	0.68	0.624
117	-3	1.47	0.360	1.45	0.366	0.51	0.702
117	-5	1.53	0.346	1.39	0.381	0.55	0.683
118	Top	1.39	0.381	1.34	0.396	0.60	1.512
118	-6	1.74	0.298	1.71	0.306	0.61	1.525
119	Top	1.30	0.407	1.26	0.417	0.67	1.594
119	-2	2.00	0.250	1.83	0.282	0.76	1.697
120	Top	2.08	0.237	2.03	0.245	1.06	2.089
120	-11.5	1.85	0.278	1.69	0.311	1.15	2.211
121	Top	1.28	0.412	1.24	0.423	0.62	1.537
122	Top	1.60	0.288	1.68	0.313	0.47	1.386
123	Top	1.27	0.414	1.30	0.406	0.71	0.611
123	-3	1.30	0.406	1.31	0.403	0.73	0.602
123	-4	3.39	0.095	3.53	0.086	0.38	0.768
124	Top	1.90	0.268	1.80	0.287	0.62	1.535
124	-3	1.62	0.325	1.59	0.331	0.91	1.882
124	-7	2.55	0.171	2.66	0.159	0.68	1.600
125	No data						
126	Top	0.41	0.752	0.45	0.732	0.64	0.641
126	-3	1.48	0.358	1.37	0.386	0.42	0.747
126	-6	1.43	0.371	1.40	0.378	0.46	0.726
127	Top	1.62	0.325	1.51	0.351	0.49	1.404
127	-3	1.89	0.270	1.87	0.274	0.46	1.376
128	Top	2.75	0.149	2.66	0.158	0.24	1.185
128	-5	0.164	0.321	1.47	0.361	0.60	1.514
129	Top	1.98	0.253	2.21	0.216	1.70	3.244
130	Top	1.44	0.369	1.38	0.384	0.49	1.404
130	-3	1.92	0.264	1.89	0.270	0.51	1.429
130	-6	2.28	0.206	2.30	0.203	0.46	1.376
131	Top	1.42	0.374	1.42	0.374	0.46	1.376
131	-3	1.54	0.344	1.53	0.346	0.52	1.434
131	-6	1.58	0.334	1.53	0.346	0.50	1.414
132	Top	1.37	0.387	1.23	0.426	0.32	1.248
132	-3	1.18	0.440	1.19	0.438	0.55	1.464
132	-6	1.48	0.358	1.48	0.358	0.42	1.338
132	-8	1.26	0.418	1.24	0.423	0.60	1.516
133	Top	1.24	0.423	1.18	0.441	0.51	1.424
133	-3	1.24	0.423	1.14	0.454	0.53	1.444
133	-6	1.52	0.349	1.45	0.366	0.61	1.526
134	Top	1.39	0.382	1.29	0.409	0.54	1.454
134	-3	2.57	0.168	2.61	0.164	0.45	1.366
135	Top	2.25	0.210	2.28	0.206	0.43	1.347
135	-3	2.19	0.219	3.95	0.065	0.98	1.972
135	-4	1.18	0.441	1.10	0.467	0.49	1.404
135	-5.5	1.42	0.374	0.00	1.000	0.88	1.840
136	Top	0.86	0.551	0.75	0.595	0.69	1.613
136	-3	1.03	0.490	0.97	0.511	0.68	1.602
136	-4	2.37	0.193	2.64	0.160	0.83	1.778
137	Top	1.74	0.299	3.95	0.065	1.25	2.378
137	-1	1.82	0.283	3.78	0.073	1.11	2.158
138	Top	1.30	0.406	1.24	0.423	0.50	0.707
138	-3	1.48	0.358	1.36	0.389	0.50	0.707
139	Top	2.50	0.177	3.22	0.107	1.05	2.071
139	-4	2.57	0.168	3.13	0.114	0.99	1.986
139	-8	2.37	0.193	3.06	0.120	1.18	2.266
140	Top	1.61	0.328	1.39	0.383	0.80	1.747
141	-9	1.73	0.301	1.64	0.321	0.76	1.693
142	Top	1.06	0.479	0.99	0.503	0.45	0.732
142	-3	1.36	0.389	1.24	0.423	0.48	0.716
142	-6	1.28	0.411	1.15	0.450	0.51	0.702
143	No data						
144	Top	2.01	0.249	1.77	0.293	0.81	1.756
145	Top	1.13	0.458	0.74	0.596	0.88	1.846
145	-2	1.82	0.284	1.89	0.270	0.80	1.737
145	-8	2.49	0.178	2.38	0.192	0.61	1.529
146	Top	1.38	0.385	1.27	0.415	0.65	1.570
146	-5	1.86	0.276	1.64	0.321	0.95	1.938
146	-10	1.89	0.270	1.84	0.279	0.80	1.743
147	Top	1.77	0.294	1.52	0.349	0.95	1.932

Table B-1. Results of RSA size analyses of 259 sediment samples.--Continued

Core	Interval (ft)	Mean (phi)	Mean (mm)	Median (phi)	Median (mm)	Std. dev. (phi)	Std. dev. (mm)
147	-5	2.02	0.246	1.82	0.284	0.76	1.689
148	Top	1.79	0.289	1.91	0.266	0.77	1.705
148	-3	0.58	0.169	0.46	0.727	0.73	1.695
148	-6	2.72	0.152	2.58	0.084	0.83	1.778
149	Top	1.42	0.373	1.43	0.371	0.60	0.659
149	-3	1.35	0.392	1.30	0.406	0.55	0.683
150	-2	1.12	0.460	1.02	0.493	0.46	1.376
150	-5	1.10	0.467	0.90	0.536	0.85	1.803
150	-6	2.34	0.198	3.94	0.065	1.34	2.532
151	-2	1.02	0.493	0.88	0.543	0.87	1.828
152	Top	1.15	0.451	0.97	0.510	0.96	1.945
152	-6	0.98	0.506	0.73	0.604	0.83	1.782
152	-8	1.57	0.338	1.33	0.399	1.03	2.042
153	-8	2.23	0.213	2.26	0.209	0.53	1.444
154	Top	1.38	0.384	1.25	0.420	0.65	1.569
155	Top	1.02	0.493	0.84	0.559	0.53	1.444
155	-3	1.15	0.451	1.12	0.460	0.46	1.376
155	-6	0.88	0.543	0.84	0.559	0.59	1.505
155	-11	2.09	0.235	2.25	0.210	0.97	1.959
156	Top	1.01	0.497	1.08	0.473	0.82	1.765
156	-2	1.18	0.441	1.14	0.454	0.86	1.815
156	-6	2.34	0.198	2.37	0.193	0.53	1.444
156	-9	2.94	0.130	3.09	0.117	0.53	1.444
157	Top	0.60	0.659	0.41	0.752	0.79	0.578
157	-3	0.65	0.637	0.50	0.707	0.72	0.607
157	-6	0.35	0.784	0.15	0.901	0.87	0.547
158	Top	2.02	0.247	2.09	0.235	0.86	1.815
158	-7	1.73	0.301	1.91	0.266	0.97	1.959
159	Top	1.46	0.364	1.36	0.391	0.80	1.741
159	-5	1.46	0.363	1.34	0.395	0.69	1.614
160	Top	0.04	0.973	-0.53	1.444	1.25	2.378
160	-3	0.44	0.737	0.30	0.812	1.21	2.313
160	-6	1.45	0.366	1.52	0.349	0.96	1.945
160	-8	2.45	0.183	2.44	1.840	0.43	1.347
161	Top	2.10	0.233	2.04	0.243	0.51	1.424
161	-3	2.62	0.163	2.70	0.154	0.48	1.395
162	Top	-0.12	1.087	-0.17	1.125	0.63	1.548
162	-4	1.92	0.264	3.20	0.109	1.12	2.173
162	-7	2.28	0.206	3.14	0.113	1.12	2.173
163	Top	0.45	0.732	0.21	0.865	0.81	1.753
163	-2	2.64	0.160	2.67	0.157	0.39	1.310
164	Top	2.26	0.209	2.28	0.206	0.55	1.464
164	-3	2.52	0.174	2.53	0.173	0.37	1.292
164	-7	2.53	0.173	2.64	0.160	0.52	1.434
165	No data						
166	Top	1.40	0.379	1.32	0.401	0.71	1.636
166	-3	1.39	0.382	1.36	0.390	0.62	1.537
166	-9	2.81	0.143	3.07	0.119	0.71	1.636
167	Top	1.10	0.466	0.95	0.517	0.64	0.641
167	-3	1.30	0.406	1.29	0.408	0.54	0.687
167	-6	2.04	0.243	1.96	0.257	0.70	0.615
168	Top	1.57	0.336	1.49	0.357	1.09	2.127
168	-6	2.20	0.218	2.10	0.234	0.78	1.720
169	Top	2.28	0.206	2.62	0.162	1.20	2.320
169	-7	1.66	0.316	1.60	0.329	1.08	2.120
170	-2	1.52	0.349	1.06	0.480	1.02	2.028
170	-6	2.24	0.212	2.41	0.188	0.77	1.705
171	Top	1.17	0.444	0.98	0.508	1.14	2.200
171	-4	0.78	0.582	0.47	0.724	0.94	1.919
171	-7	1.59	0.332	1.32	0.400	1.16	2.239
172	Top	0.17	0.889	-0.06	1.042	0.86	1.815
172	-3	1.52	0.349	1.49	0.356	0.53	1.444
172	-5	1.94	0.261	2.13	0.228	0.86	1.815
172	-7	1.03	0.490	1.16	0.448	0.88	1.840
173	Top	2.23	0.213	2.22	0.215	0.55	1.464
173	-3	0.43	0.742	0.25	0.841	0.57	1.485
173	-6	0.61	0.655	0.35	0.785	1.06	2.085
173	-9	-.96	0.514	0.88	0.543	0.56	1.474
174	-3	0.74	0.599	0.62	0.651	0.48	1.395
174	Top	1.46	0.363	1.41	0.376	0.73	1.659
174	-6	2.00	0.250	2.10	0.233	0.83	1.778
175	Top	0.77	0.586	0.53	0.692	0.82	0.566
175	-3	1.46	0.363	1.29	0.408	0.56	0.678
175	-6	1.08	0.473	1.11	0.463	1.18	0.441
175	-9	0.75	0.594	0.48	0.776	0.83	0.562
176	Top	2.48	0.179	2.51	0.176	0.41	1.329
176	-3	2.25	0.210	2.40	0.189	0.79	1.729
177	Top	1.83	0.281	2.10	0.233	0.92	0.528
177	-3	2.13	0.228	2.11	0.231	0.41	0.752
178	Top	1.07	0.476	0.96	0.514	0.42	0.747
178	-3	1.52	0.348	1.42	0.373	0.45	0.732
178	-6	1.47	0.360	1.36	0.389	0.61	0.655
178	-10	0.83	0.562	0.92	0.528	0.99	0.503
179	Top	0.73	0.603	0.75	0.595	1.09	2.129
179	-3	1.19	0.438	1.26	0.418	0.96	1.945
179	-6	1.43	0.371	1.77	0.293	1.35	2.549
179	-8	2.06	0.240	2.36	0.195	1.01	2.014
180	Top	1.06	0.480	0.93	0.512	0.67	1.591
180	-4	1.59	0.332	1.53	0.346	0.62	1.537
180	-6	1.60	0.338	1.65	0.319	0.68	1.602
180	-9	1.67	0.314	1.77	0.293	0.71	1.636
181	Top	1.75	0.297	1.54	0.344	0.81	1.758
181	-8	2.02	0.246	1.96	0.257	0.74	1.676
182	Top	2.12	0.230	2.02	0.247	0.71	1.633
182	-6	2.00	0.250	1.83	0.285	0.90	1.872
183	Top	1.85	0.278	1.73	0.302	0.88	1.843
183	-7	2.80	0.144	2.78	0.146	0.66	1.582
184	Top	1.78	0.291	1.68	0.312	0.43	0.742
184	-3	1.90	0.267	1.85	0.277	0.44	0.737
184	-6	1.38	0.384	1.19	0.438	0.50	0.707
184	-9	1.01	0.496	0.94	0.521	0.70	0.615
185	Top	1.42	0.373	1.39	0.381	0.49	0.712
185	-3	0.47	0.721	0.42	0.747	0.47	0.721
185	-6	0.86	0.550	0.75	0.594	0.48	0.716
186	Top	1.84	0.279	1.65	0.318	0.95	1.932
186	-6	2.24	0.212	2.38	0.192	0.94	1.919
186	-10	1.92	0.265	1.74	0.300	1.01	2.012
187	Top	1.19	0.440	1.04	0.485	0.89	1.859
187	-8	2.97	0.127	3.14	0.114	0.77	1.700
188	Top	1.37	0.387	1.19	0.437	0.70	1.626
188	-3	1.83	0.282	1.62	0.326	0.96	1.943
188	-8	1.63	0.322	1.49	0.355	1.10	2.147
189	Top	1.99	0.252	2.02	0.247	0.83	1.774
189	-7	2.85	0.139	2.81	0.643	0.55	1.466
190	-5	1.09	0.470	1.06	0.480	0.64	1.558
191	Top	1.66	0.316	1.94	0.261	1.30	2.462
191	-3	1.32	0.401	1.26	0.418	1.12	2.173
192	Top	1.12	0.460	0.90	0.535	1.01	2.013
192	-6	1.77	0.292	1.56	0.340	1.23	2.344
193	Top	0.84	0.559	0.82	0.566	0.96	1.945
193	-3	2.15	0.225	2.66	0.156	1.18	2.266
193	-6	3.15	0.113	3.23	0.107	0.37	1.292
194	Top	1.09	0.470	0.98	0.507	1.00	2.000
194	-5	2.33	0.199	2.43	0.186	0.55	1.464
194	-8	1.94	0.261	1.90	0.268	0.87	1.828
195	Top	2.65	0.159	3.02	0.123	0.88	1.840
195	-3	2.61	0.164	2.85	0.139	0.74	1.670
196	Top	2.75	0.149	2.77	0.147	0.43	1.347

Meisburger, Edward P.
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